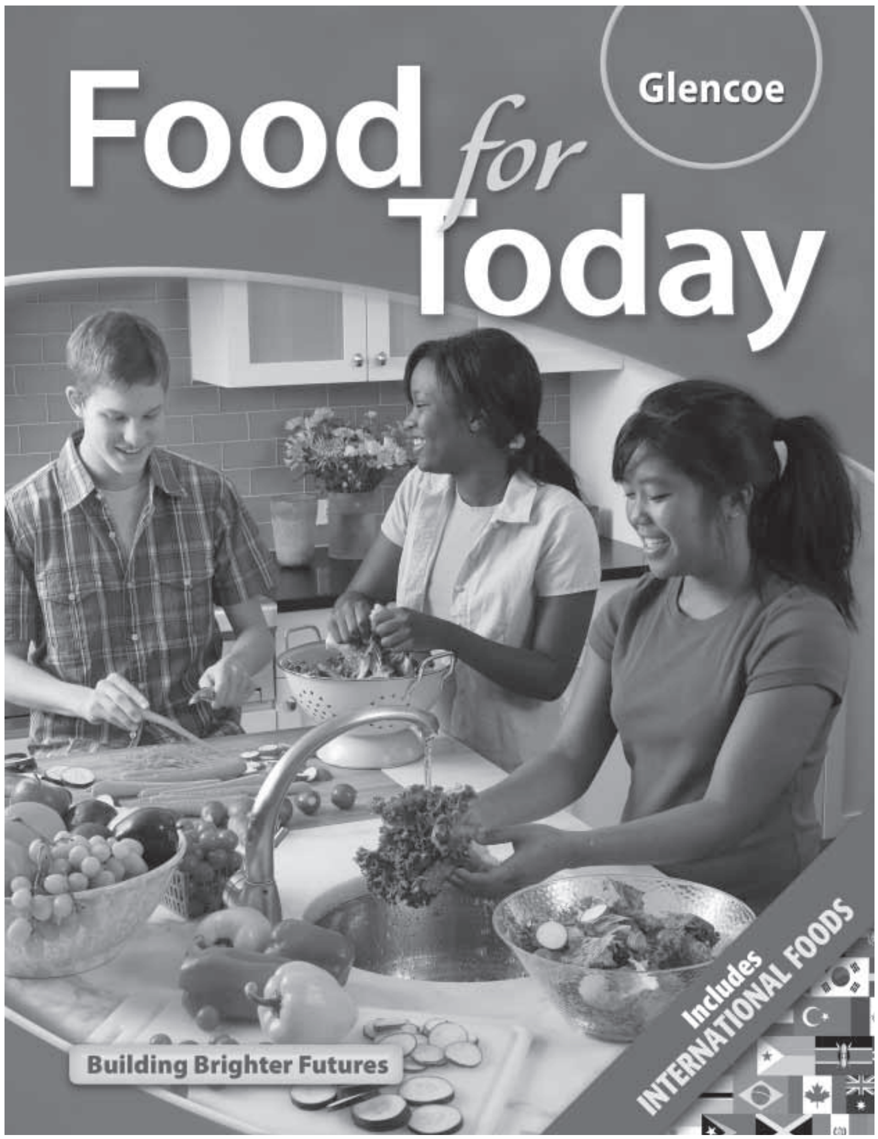
Food *for* Today

Food Science Experiments



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Safety Notice

The reader is expressly advised to consider and use all safety precautions described in this booklet or that might also be indicated by undertaking the activities described herein. In addition, common sense should be exercised to help avoid all potential hazards and, in particular, to take relevant safety precautions concerning any known or likely hazards involved in food preparation, or in use of the procedures described in *Food for Today*, such as the risk of knife cuts or burns.

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Why Teach Food Science?

Today, the educational community is placing great emphasis on incorporating more academics into the educational process. Incorporating food science into foods and nutrition classes gives students an opportunity to develop important skills and gain additional concepts. It can also help many students overcome any fear of science-related subjects that they may have developed over the years. Having the opportunity to experience food science first hand gives students a new approach to understanding food and nutrition.

Essential Skills Learned

While the word science can mean many things, performing the experiments included in this booklet, students will use science in new ways. They will develop several important types of basic life skills, including life management skills. Some of the most significant are listed here.

Critical Thinking and Other Thinking Skills

Science enhances students' abilities to observe, think about what they perceive, draw conclusions, solve problems, and make decisions. These same skills are critical for making informed decisions and choices in daily life.

The food science experiments included in this booklet are designed to improve students' critical thinking skills. Observations and conclusions help build decision making skills, critical thinking skills, and the ability to investigate and seek out answers that can prepare them for future events.

Learning from Trial and Error

When approached analytically, mistakes can provide valuable information and insights.

Conducting food science experiments is one way to help students understand that "failures" provide an opportunity to learn. The trial and error process in a scientific experiment provides ingredients and methods for learning. Analyzing why one variation "failed" is often the only way to understand why others produce the desired results.

Academic Skills

Academic skills such as reading, writing, and math are an integral part of conducting scientific experiments. As part of conducting food science experiments, students learn the importance of reading directions carefully, measuring accurately, and following directions exactly as they are written.

In making observations, students must find the right word to describe the product specifically and write down their descriptions. They must reach conclusions about their experiment and express their conclusions clearly in writing.

Consumer Applications

Understanding basic scientific methods and principles can help students become retentially better consumers. A familiarity with scientific terms and methods will help students evaluate the scientific and technological changes as they are reported in the media. In addition, knowledge of scientific terms will help students understand and use the information on food labels and in consumer reports. Technology is a part of the practical side to scientific knowledge. As technology changes, so does the potential for learning.

Food Preparation Skills

The study of food science introduces students to some of the natural laws that govern food preparation. Too often, these basic principles are ignored in food preparation. Yet once students understand that nutrition, aroma, flavor, color, and texture are all part of the chemical properties of food and cooking procedures, they can become more skilled in choosing and preparing nutritious meals.

Experiments will provide students with an opportunity to observe natural scientific laws at work. Students will gain valuable experience in the scientific aspects of food preparation and the possibility to increase creativity.

Careers in Food Science

Exposure to food science may encourage some students to consider a career in food science or a similar scientific career. Just the act of performing simple but informative scientific experiments successfully may be enough to spark an interest in the subject.

Food science careers range from agricultural scientists, to food chemists, to health and food safety inspectors. This broad spectrum of careers may hold hidden appeal for students who are interested both in food and in science-related topics. Find the career features in the text ("Food for Today"). Look under Career Pathways, and try to pick out the careers that are applicable to an area related to food science.

Students can be introduced to the requirements necessary for specific food-related careers.

Using the *Food Science Activities* Booklet

This *Food Science Activities* booklet is designed specifically to help students learn food science through hands-on experiences. Here you will find food science experiment worksheets as well as additional student handouts and teaching guidelines. This material, along with related food science material in the student text and Teacher's Wraparound Edition, is designed to make the study of food science uniquely interesting and informative.

Organizing Your Approach To Food Science

To help you plan your approach to teaching food science concepts, use the "Guidelines and Answer Key to Food Science Experiments" provided on pages 8 to 23. For each chapter, these guidelines show what information and resources relating to food science are available in the *Food for Today* student text, Teacher's Wraparound Edition, and *Food Science Activities* booklet.

How you use this information will depend on your approach to food science. Many options are possible. For example, you can:

- Incorporate food science concepts into your day-to-day teaching of food and nutrition. On the guidelines, check off those topics and activities that you wish to emphasize in your lessons.
- Draw upon the food science activities and experiments listed when planning enrichment, independent study, or extra credit projects.
- Periodically devote one or more days to an in-depth treatment of food science. Use the guidelines to see what food science topics can be related to those chapters and what resources are available.
- Plan the entire course around food science topics. Use the guidelines in conjunction with the Teacher's Wraparound Edition to decide what chapters and topics to cover and how many days to devote to each.
- Incorporate the career features into discussion topics, possible future goals, and areas of interest.

Using The Food Science Experiments

Twenty-five food science experiments are provided in this *Food Science Activities* booklet. These experiments will help students understand and apply some of the basic scientific principles that govern food preparation. The experiments offer a simple introduction to food science, using food items and equipment available in the typical Family and Consumer Sciences laboratory.

Rather than attempting to make new discoveries, which is beyond the scope of this course, students will be duplicating experiments that have already been successfully made. The experiments will give students experience in following laboratory procedures, observing results, and drawing their own conclusions. Performing the experiments themselves will help students understand and remember concepts more effectively than textbook reading.

The Scientific Method

The experiments are based on the scientific method, a general set of ground rules for approaching scientific experiments. The scientific method can be summarized as follows:

1. Observe an occurrence and state the problem.
2. Develop an hypothesis to explain the occurrence or solve the problem.
3. Test the hypothesis by conducting experiments and making observations.
4. Interpret the data from the experiments.
5. Draw conclusions based on the data.
6. Publish the results and your conclusions so that other people may benefit from your experience.

Keeping a Food Science Journal

The sixth step of the scientific method is one of the most important. It is also probably the most overlooked in student experiments. To reinforce the idea that the experiment is not complete until the results are published, encourage students to set up their own Food Science Journals.

In their journals, students should write a summary of each experiment they perform, along with their conclusions. Emphasize that keeping a journal of their food science experiments will help students later, since many of the experiments provide answers and remedies for common cooking problems. By keeping a well-organized journal, students create for themselves a valuable reference for future use.

You may choose to have students use a standard format for writing their results, but it is best not to provide preprinted forms for them to fill out. The idea behind the journal is to allow students to become comfortable with expressing their thoughts, ideas, and discoveries in writing. Encourage students to be thorough but concise in their summaries and conclusions. You may also want to suggest that students number the pages of their notebooks and create an "index" in the back to help them find topics more easily later.

Laboratory Safety

Safety is always of primary importance in any classroom or laboratory situation. The food science experiments in this booklet are designed for maximum safety. None of the experiments involve toxic chemicals or hazardous substances of any kind. Students will be working with ordinary food and equipment items such as vinegar, baking soda, saucepans, and measuring spoons. Other than basic rules of safety and sanitation—which should always be enforced in the foods lab—no special precautions need to be taken when conducting these experiments. You may wish to have students review the safety and sanitation principles found in Unit 5 of the student text. A form containing standard rules for safety and sanitation appears on pages 26-28 of this *Food Science Activities* booklet. This form is meant to be read by the student with a parent or legal guardian. Afterwards, the student and the parent or legal guardian should sign the signature slip provided on page 28 and return it to you.

Student Experiment Worksheets

Directions for conducting each experiment are found in the reproducible student experiment worksheets. Each experiment worksheet includes nine sections:

- Objective (purpose of experiment)
- Look for These Terms (vocabulary)
- Text Reference
- Background Information
- Supplies
- Procedure
- Observations
- Conclusions
- Extra Ideas

For more information on the content of these sections, see the reproducible student handout, "Conducting Food Science Experiments," pages 26-27.

Unless noted otherwise, supplies listed on the experiment sheet are those needed by each lab group. The total number or amount of supplies needed will depend on how many lab groups will be working at one time.

In the "Extra Ideas" section of the experiment worksheet, suggestions are given for using products resulting from the experiment. Every effort has been made to design the experiments so food is not wasted. In addition, additional ideas are included to extend learning.

Guidelines and Answer Key

Teacher's guidelines (including an answer key) are provided for each experiment. The guidelines begin with a statement of the experiment's purpose. Under the heading "*Food for Today* Reference" is a list of chapters with which the experiment could be used. "Procedure Hints" gives suggestions that should help the experiment run smoothly. "Expected Results" summarizes the typical outcome of the experiment. This is followed by an answer key for the "Conclusions" section of the students' worksheet. The guidelines conclude with suggested "Discussion Questions" for classroom follow-up.

Getting Started

Before beginning the first experiment, have students read and discuss the handout, "Conducting Food Science Experiments," pages 24-25. This handout will familiarize students with the format of the experiment worksheets. It also explains general procedures for conducting experiments and making observations. You may also wish to provide students with two additional handouts, "Glossary of Selected Food Science Terms" and "Vocabulary for Sensory Evaluation." Students will find it helpful to refer to these handouts throughout their study of food science.

You may wish to introduce students to food science with Experiment 1, "Clean It Up!" This experiment gives students observation skills that will be used in almost all of the experiments.

Pointers For Success

Here are some general suggestions for successfully conducting the experiments.

- Before each experiment, read "Background Information" with students. Also review the information from the textbook pages shown on the worksheet.
- Go over the worksheet with students so they understand exactly what they are to do in the "Procedure," "Observations," and "Conclusions" sections.
- Emphasize the importance of writing down the data as it is observed. If students rely on their memories, they may become confused or forget what they observed.
- Stress the importance of following directions carefully. If a step is accidentally omitted or carried out improperly, the experiment will not have the best results.

- Encourage accurate labeling. If items are mislabeled or labels are removed, students will be unable to make the necessary observations or the results of the experiment will be incorrect or misleading.
- Help students learn to develop their powers of observation. At first, students may have to make conscious efforts to see the details of what they are observing. Try this exercise: Give students five minutes to write down a detailed description of the route they take to school each morning. Discuss how well they remember the details.
- When students are testing flavors, they should take a sip of water or rinse their mouths between samples. This removes traces of the previous sample, which could affect the flavor of the next one.
- Encourage students to have the handout "Vocabulary for Sensory Evaluation" with them as they are observing the products of the experiments. Using the list will help students make concise, accurate observations.
- Emphasize that the purpose of food science experiments is to learn how and why specific ingredients or procedures create specific results. Nonstandard food products are expected in some experiment variations and should not be considered "wrong" or "incorrect."

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Guidelines and Answer Key for Food Science Experiments

Experiment 1:

The Dry Made Moist

Purpose

In this experiment, students soak two samples of the same fruit—one that has been dried and one that is fresh—and observe how much water is reabsorbed by the dried fruit.

***Food for Today* Reference**

Chapter 30, "Fruits."

This experiment may also be used with Chapter 26, "Cooking Methods"; Chapter 29, "Preserving Foods at Home"; Chapter 33, "Legumes, Nuts & Seeds."

Procedure Hints

Emphasize the importance of not pressing too hard in an effort to dry fresh fruit. This is especially important if you are using soft-flesh fruits, such as plums or peaches.

If you have a dehydrator in the classroom, you may wish to dehydrate your own food samples one or two days prior to assigning this experiment. Then have students reconstitute their own samples.

If there are students in the class whose math skills are somewhat lacking, permit them to work in teams to do the computation in the "Observations" phase of the experiment. You can further simplify the process for such students by recasting the formula in plainer language (e.g., "Divide the amount you got in the second column by the amount you got in the first column. Then multiply the result by 100 to find the percentage of new weight the fruit gained from the addition of water.").

Expected Results

Results may vary, but expect most samples of dried fruit to regain up to one-third or more of their original weight.

"Conclusions" Answer Key

1. Answers will vary.
2. Answers will vary.
3. Differences should be discernible in the flavor and texture of the samples, with the fresh fruit having a firmer but less resilient texture than the dried fruit.

Discussion

1. What kind of change does fruit undergo when it is dried—chemical or physical? *(Help students appreciate that it is a physical change, since the fruit can be reconstituted to a large extent.)*
2. Do you think this process would work for reconstituting dried meat, such as jerky? Why or why not? *(Dried meats have had fat as well as moisture extracted from them and, therefore, cannot be reconstituted.)*
3. In what way does drying change nutrient value? *(It reduces water content; and condenses other nutrients into a smaller serving.)*

Experiment 2:

Reduction of Snack Food Fat

Purpose

In this experiment, students prepare home-baked potato chips and compare the finished product with commercial potato chips.

***Food for Today* Reference**

Chapter 7, "Nutrients at Work."

This experiment may also be used with Chapter 11, "Keeping a Healthy Weight"; Chapter 16, "Meal Planning"; Chapter 31, "Vegetables."

Procedure Hints

If the class foods lab has a food processor, guide student participants in the proper use of this kitchen tool. Emphasize the need for caution when handling the blades, which are razor-sharp, especially since this experiment requires the use of the feed attachment.

A similar caution will need to be applied to the use of a kitchen knife. Demonstrate the proper method, noting the importance of lining up the blade at a consistent angle to achieve the desired result.

Expected Results

Results will vary depending on personal preference.

"Conclusions" Answer Key

1. Answers will vary among respondents.
2. Answers will vary among individuals, although it should be emphasized that synthetic fats have been the subject of some controversy because of studies that suggest they may carry off vital carotenoids during digestion.

Discussion

1. What other foods should you cut a small slice from before cutting or slicing? *(Any rounded or irregularly shaped fruit or vegetable that would not otherwise remain flat on a cutting board.)*
2. What other Dietary Guidelines does the homemade version of potato chips help you meet? *(The guideline to eat more vegetables and fruits, as well as the recommendation to increase dietary fiber.)*
3. Name some examples of nonsavory (i.e., sweet) snack foods that are commercially available in both full-fat and low-fat versions? *(Answers might include ice cream and frozen yogurt.)*

Experiment 3:

The Question of Additives

Purpose

In this experiment, students test for the presence of sulfur dioxide in dried fruit.

Food for Today Reference

Chapter 3, "The Food Supply."

This experiment may also be used with Chapter 20, "Food Safety & Storage"; and Chapter 30, "Fruits."

Procedure Hints

One of the items in the "Supplies" list for this activity, hydrogen peroxide, is not readily found in many school foods labs. However, it is frequently present in home medicine cabinets and first aid kits. It can be purchased at relatively low cost and is easily obtainable at pharmacies and at health and beauty aids outlets.

Be sure students follow the instruction in step 1, which advises them to see to it that all their equipment has been thoroughly washed and dried with a lint-free cloth. Explain that failing to follow this instruction may jeopardize the outcome of the experiment.

Expected Results

Results will vary depending on whether the sample of dried fruit has indeed been sulfured. To verify that the activity was carried out properly, inspect the package of the dried fruit beforehand to see if sulfur dioxide is listed as an ingredient.

"Conclusions" Answer Key

1. Answers should include those containing sulfur dioxide.
2. Those that produced a white solid; those that did not; some were intended for more immediate use since they were not treated in a manner that would increase their shelf life.
3. It enhances their appearance and, thus, their appeal.

Discussion

1. What other foods are routinely preserved? *(Answers will vary; be sure students appreciate that a high percentage of foods sold in supermarkets are treated with preservatives.)*
2. Why are so many foods preserved? *(Foods are often shipped far from where they are produced and, upon arriving at a food store, may be held on the shelf for a long time; preservatives increase their shelf life.)*
3. How can you tell if a preservative listed on a food package is safe to eat? *(All preservatives are overseen by the Food and Drug Administration; those that are unsafe are not used or will be recalled.)*

Experiment 4:

Check That Speed—Chemical Leavening Agents

Purpose

This experiment demonstrates how baking powder, baking soda, and cream of tartar react with various liquids to produce carbon dioxide.

Food for Today Reference

Chapter 44, "Baking Basics."

This experiment may also be used with Chapter 45, "Quick & Yeast Breads"; and Chapter 46, "Cakes, Cookies & Candies."

Procedure Hints

The experiment involves seven different reactions. They must be conducted one at a time, with observations made on one test before beginning the next one. When the Observation Chart is filled, students can draw conclusions.

Timing is critical in this experiment because seconds are involved. A stopwatch would be an ideal way to keep time, but a watch or clock with a second hand can be used.

If custard cups and other equipment are to be reused, they must be carefully washed in warm, sudsy water rather than just quickly rinsed. Even the slightest trace of a residue from one part of the experiment can affect the reaction in the next part.

Expected Results

Cups A and B will not react. The other cups should "fizz up" for 10-30 seconds, then continue to produce tiny carbon dioxide bubbles for several minutes. For differences in the type and length of the reactions, see numbers 1-6 below.

"Conclusions" Answer Key

1. Cups A and B (baking soda and water)
2. Cup C (baking soda and vinegar)
3. Cups F and G (double-acting baking powder)
4. Probably Cup F (double-acting baking powder and cold water), although D, E, and G are other possible answers.
5. Carbon dioxide gas. (Students may or may not have noticed vapor.)
6. A chemical reaction between acid and base produces carbon dioxide gas. Baking soda and vinegar react quickly and powerfully, but stop fizzing sooner. Double-acting baking powder reacts more slowly. Heat speeds up the production of carbon dioxide.

Discussion

1. If a quick bread recipe used milk and you wanted to use buttermilk to give it a different flavor, what adjustment would you have to make? Why? *(Substitute baking soda for part of the baking powder. Baking soda provides the base to balance the acid in the buttermilk and produce carbon dioxide for leavening.) (Have students look up quick bread recipes using baking powder and baking soda and discuss the reasons for the leavenings used.)*
2. What does this experiment tell you about storing chemical leavening agents? *(Must be stored in tightly closed container in dry area; moisture begins chemical reaction.)*
3. Why do you think double-acting baking powder is so popular? How does it differ from homemade baking powder (baking soda and cream of tartar)? *(Most of the leavening action of double-acting baking powder is released after the mixture starts to bake. Therefore it gives better results. When homemade baking powder is used, the mixture must be put in the oven quickly or it may not rise properly.)*

Experiment 5:

Interactive Vegetables/Effects of Acids & Bases

Purpose

Orange, red, green, and white vegetables are cooked in an acid, a base, and plain water to determine the effects of the pH of the cooking liquid on the vegetables.

Food for Today Reference

Chapter 31, "Vegetables."

Procedure Hints

To conduct the complete experiment, at least four lab groups are needed. Assign each group to work with one kind of vegetable representing a specific color pigment. If it is not possible to have four lab groups working at one time, adapt the experiment accordingly. Each group may be able to complete more than one variation in the time allotted, or the experiment may be extended over more than one class period. You may also simply eliminate one or more kinds of vegetables from the experiment.

If you do not have enough saucepans to supply each group with three, have students cook one variation at a time. Make certain students wash equipment carefully after each variation.

After the experiment, have each group report its findings to the class. Let other students examine the vegetables to note differences.

Extend the experiment by having students make a master chart showing the characteristics of the four different colors of vegetables cooked under the various conditions.

To demonstrate the reversibility of the color change in pigments, have students treat the cooking liquids in the glass jars before the liquids are poured into the storage container. Have them add a base to "B—Acid" and an acid to "C—Base" and observe any changes in color. The color change for anthocyanin and flavone is reversible, while the color change for chlorophyll is irreversible.

Expected Results

A—Cooked in water: all vegetables remained the same color, unless overcooked.

B—Cooked in acid (vinegar, lemon juice):

- *broccoli*—olive green; tough texture; little change in aroma.
- *red cabbage*—red-violet; tough texture; some change in aroma.
- *cauliflower*—light cream color; tough texture; little change in aroma.
- *carrots*—no color change; tough texture; no change in aroma.

C—Cooked in base (baking soda):

- ◆ *broccoli*—bright green; mushy-soft; little change in aroma.
- ◆ *red cabbage*—violet-blue; very mushy; little change in aroma.
- ◆ *cauliflower*—yellowish; mushy-soft; little change in aroma.
- ◆ *carrots*—darker orange color; softer texture; little change in aroma.

"Conclusions" Answer Key

1. Yes, if they contain the same color pigment, because the pigments react the same in acids and bases.
2. Acids toughen texture; bases soften, making vegetables mushy.
3. Answers will vary.
4. Other ingredients in recipe can affect the vegetable color and texture.
5. Vegetables would be tough; b) vegetables would be proper texture because they were cooked until tender before tomatoes were added.
6. Hard water is basic; would get better results if acid added to vegetables when cooking. (However, if hardness is due to calcium or magnesium salts, vegetables will have a firm texture.)

Discussion

1. Discuss the general effect acids have on vegetables. *(Acids intensify color and toughen texture.)*
2. Discuss the general effect bases have on vegetables. *(Brighten green color of chlorophyll, but turn red of anthocyanins blue and white of flavones a more intense cream yellow. Give a mushy texture, which causes loss of nutrients from vegetable cells.)*
3. Name other vegetables in the same color categories. *(Green: beans, brussels sprouts, greens; White: potatoes, turnips, parsnips; Yellow/orange: winter squash. Beets, although red, do not have anthocyanin pigment that red cabbage has.)*

Experiment 6:

Changing Character—Caramelization

Purpose

In this experiment, students compare the sensory qualities of sautéed onion with raw onion.

Food for Today Reference

Chapter 28, "Creative Additions."

This experiment may also be used with Chapter 36, "Meat"; and Chapter 46, "Cakes, Cookies & Candies."

Procedure Hints

Write the term caramel on the board. Ask students to provide a definition. In all likelihood, most will mention a candy, rather than a chemical process involving sugar.

Having clarified the meaning, remind or point out to students that caramelization is achieved only at a high temperature and that, therefore, spots of caramelized browning on food tend to be quite hot. Students should take proper safety precautions when touching the foods in this experiment or any other foods that become caramelized.

Expected Results

Results will vary depending on personal tastes and preferences, although virtually all students will be able to distinguish between the raw and caramelized samples.

"Conclusions" Answer Key

1. Answers will vary.
2. No; the sugar content in the vegetable is not uniform throughout.
3. No, because the onion managed to brown.
4. Students should recognize that roasting is an alternative, and somewhat more healthful, way of achieving caramelization.

Discussion

1. What is the relationship between caramelization and making the candy caramel? What is the difference between the candy caramel and caramelized fruits and vegetables? *(Help students recognize that both result from applying high heat to sugar; in the case of candy making, the sugar is refined, whereas in vegetables and fruits, it is natural.)*
2. If you roasted cubes of potato on a humid day, do you think they would turn brown? *(Yes; the heat inside the oven is dry regardless of the ambient humidity.)*
3. Why does the sugar in the onion not brown instantly? *(It takes a moment for the moisture in the vegetable to evaporate.)*

Experiment 7:

Acids Affecting Protein

Purpose

To demonstrate how protein molecules change when they come in contact with an acid.

Food for Today Reference

Chapter 35, "Eggs."

This experiment may also be used with Chapter 34, "Dairy Foods"; and Chapter 36, "Meat."

Procedure Hints

The shape of protein molecules can be changed (denatured) by many different methods. One method is to add acid to certain foods, such as milk. The process begins by thickening the milk. As denaturation continues, the milk turns grainy, then it curdles, and finally it coagulates into curds which separate from the liquid.

This experiment has practical value. If a recipe calls for sour milk, plain milk can be soured (denatured) by adding vinegar.

Heat speeds up the denaturation process. When milk is added to an acid mixture and heated, it can curdle easily.

Expected Results

In general, the two vinegar mixtures will have the following appearance:

- *1 tsp. (5 mL) vinegar:* immediately—no change; 5 min.—grainy; 10 min.—slightly curdled; 15 min.—slightly more curdled and translucent.
- *2 tsp. (10 mL) vinegar:* immediately—curdled; 5 min.—curdled; 10 min.—curdled; 15 min.—curds separated, clear liquid.

"Conclusions" Answer Key

1. The control showed no reaction. B and C curdled—the reaction was faster in C.
2. It will get grainy and begin to curdle.
3. Should be C after 15 min.
4. Any recipe, such as one for quick bread, calling for sour milk; also any recipe that mixes milk and an acid, which would call for care in preparation to avoid curdling.

Discussion

1. What happens when milk is mixed with an acid? *(The protein changes, going through different steps from grainy until it curdles.)*
2. Of what practical use is this information? *(Be cautious when working with milk mixtures containing acid foods so they don't curdle.)*
3. When would you want protein in milk to denature? *(When making sour milk or cheese.)*

Experiment 8:

The Gelatin Effect

Purpose

This experiment demonstrates the use of gelatin as a stabilizing agent in a frozen dessert.

Food for Today Reference

Chapter 34, "Dairy Foods."

This experiment may also be used with Chapter 41, "Salads & Dressings"; Chapter 42, "Stir-Fries & Casseroles"; and Chapter 43, "Soups, Stews & Sauces."

Procedure Hints

This experiment takes two days. On the first day, students prepare two versions of the dessert and freeze them. On the second day, they make their observations. The dessert must be allowed to freeze completely so accurate observations can be made.

Any frozen fruit can be used in place of the raspberries. Don't substitute whipped topping for the whipping cream. The topping contains stabilizers and will not give the same results as whipping cream.

Expected Results

In general, the version with the gelatin should have a better appearance, smoother texture, and slower melting rate. The flavor preference will be a matter of opinion.

"Conclusions" Answer Key

1. A—Gelatin, because of its stabilizing action
2. A—Gelatin, because it has smaller ice crystals.
3. B—No gelatin, because it was not stabilized so the ice crystals melted quickly.
4. Will vary—personal preference.
5. Stabilizers improve the texture of frozen desserts.

Discussion

1. What other methods could be used to make the mixture smooth? *(Add more fat, beat mixture during freezing.)*
2. Read labels on different brands of commercial ice cream, including "natural" varieties. What ingredients act as stabilizers? *(Answers will vary, depending on label. Common stabilizers include guar gum, carrageenan, locust bean gum, alginate, agar, lecithin, sodium carboxymethylcellulose, and gelatin.)*

Experiment 9:

What Is in Baking Powder?

Purpose

In this experiment, students prepare and evaluate two versions of the same quick bread recipe, one made with baking powder, the other with a leavening agent fashioned from other common ingredients.

Food for Today Reference

Chapter 44, "Baking Basics."

This experiment may also be used with Chapter 45, "Quick & Yeast Breads."

Procedure Hints

Before beginning, check the "sell by" dates on the baking powder and sodium bicarbonate. If either is past expiration, postpone the experiment until fresh supplies can be purchased.

Be sure that students preheat the oven. While it is heating, review with them the concept of a control in a scientific experiment, eliciting possible examples. (The most familiar example of a control is an actual medication that is tested during clinical trials along with a placebo.)

Emphasize to students the importance of following the recipe exactly, whether they are working from the control recipe (Variation A) or the alternate (Variation B).

Insist that students follow proper kitchen safety procedures, such as using oven mitts when handling hot pans or utensils. Be sure that sticky notes or other paper used in carrying out the experiment is not introduced into the lab environment until all pans and their contents have cooled sufficiently. The glue on some sticky notes may be toxic when heated, and any paper can catch fire if it is exposed to enough heat.

Expected Results

Because sodium bicarbonate and cream of tartar are the two ingredients found in commercial baking powder, the two loaves should be identical. If they are not, instruct students to repeat the activity, this time under your close scrutiny.

"Conclusions" Answer Key

1. The two should have risen to the same height.
2. No differences should have been detected.
3. Students should recognize that these two ingredients—sodium bicarbonate and cream of tartar—are found in commercial baking powder. They can verify this by checking the ingredients panel on the baking powder package.

Discussion

1. Under what circumstances might the knowledge gained from this experiment come in handy? *(Should you find that you are out of baking powder, you can always substitute this equivalent.)*
2. How can you investigate whether other common ingredients can be easily constructed from household ingredients? *(By reading the ingredients list on the label.)*
3. What substitutions have you learned about in your textbook that reduce the amount of fat in a recipe? *(Answers will vary; one possibility is substituting lowfat yogurt for sour cream.)*

Experiment 10:

Chemical or Physical—That Is the Question!

Purpose

In this experiment, students observe two kinds of changes that can occur in foods, physical and chemical, as the changes apply to the dissolving of substances.

Food for Today Reference

Chapter 4, "Food Science & Technology."

This experiment may also be used with Chapter 26, "Cooking Methods."

Procedure Hints

To highlight the changes that salt undergoes, you may recommend that students make sketches of the cubelike appearance of the crystals when viewed under magnification. Students may later compare the appearance of the salt with their sketches in the first step under "Observations."

Have a volunteer read aloud the word nonreactive, along with its definition (constructed of a nonporous material not capable of inducing a chemical change). Note that students will see this term used from time to time in recipes.

Expected Results

The salt that dissolved will be restored once the liquid boils away, whereas the baking soda undergoes a change in chemical composition and, hence, cannot be reclaimed.

"Conclusions" Answer Key

1. There was little difference between the two.
2. Salt; it had the same appearance and taste as before the experiment; physical change.
3. Answers will vary, though students should be in agreement that the substance was a residue other than baking soda; its appearance was altered; chemical change.

Discussion

1. Why is knowing about physical and chemical changes valuable for cooks? *(Understanding such principles of food preparation increases their cooking success.)*
2. Is glass the only nonreactive substance used to make cookware? Explain. *(No, any ceramic cookware is also nonreactive because it is porous.)*
3. Does sugar undergo a chemical or physical change when it is dissolved in water? How can you tell? *(Help students understand that it undergoes a chemical change, because it unites with the water to form what food professionals call a simple syrup; the sugar cannot be reclaimed.)*

Experiment 11:

Clean It Up!

Purpose

In this experiment, students explore the effects of water temperature on the cleaning of dishware.

Food for Today Reference

Chapter 20, "Food Safety & Storage."

Procedure Hints

You may want to use this experiment with Experiment #23, which deals with cleanliness and sanitation to deter foodborne illness. Reiterate the need for soap. Encourage a discussion about healthy habits.

Expected Results

Results will indicate that the hot water with the soap gets the dishes the cleanest.

"Conclusions" Answer Key

1. No, they need soap. Answers will vary.
2. No. Answers will vary.
3. Answers will vary, but should include a discussion about careful sanitation.

Discussion

1. Do commercially prepared cleaners work better than homemade ones? *(Not necessarily.)*
2. Develop a different observation chart for your experiment. What would you include? *(Answers will vary.)*
3. How can you help minimize the likelihood of any food borne illness in your home kitchen? *(Keep it clean.)*

NOTE: Have students conduct a workshop for non-FACS students on "kitchen cleanliness" and its importance on good health. Have students practice making labels promoting the benefits of your "new soap product." Allow students to make labels on the computer or produced by hand (drawings, pastels, paints, collage, colored pencils, etc.). Encourage students to be creative, informative, and persuasive. Encourage students to create a "Clean Kitchen" check-off sheet—"Keeping the Kitchen Clean."

Experiment 12:

Grain Retain—Water Retention When Cooked

Purpose

In this experiment, students cook small amounts of two different grains to determine how much water each soaks up in the course of cooking.

Food for Today Reference

Chapter 32, "Grain Products."

This experiment may also be used with Chapter 9, "Water & Phytochemicals."

Procedure Hints

Remind students of the many dried foods that expand when they are merely exposed to water, such as dry beans. Note that in this experiment, students will test a related principle, the amount of moisture grains absorb when cooked.

Note that this experiment can be done only with regular rice, not instant.

Be sure students carefully follow the package directions for the cooking of the grain they have chosen or been assigned. In the case of cooking pasta, the amount of water may have to be adjusted. Refer students to the formula in Chapter 24 for changing a recipe yield.

Expected Results

Results will vary slightly with the wheat grain chosen and the precise amount of cooking time each grain or grain product received.

"Conclusions" Answer Key

1. Answers to the first part of the question will vary; by comparing the dry and cooked weights.
2. The answer depends on whether the grain was drained or not, since draining eliminates some of the excess water absorbed, but only if it is carried out immediately.
3. Answers will vary but should be supported by a solid foundation of critical thinking.

Discussion

1. What foods have naturally high water contents to begin with? *(Vegetables and fruits are examples of foods high in water content.)*
2. If so many foods contain water, why do you think nutritionists advise drinking six to eight glasses of water daily? *(One cannot be sure of eating enough foods high in water content; drinking six to eight glasses of water leaves nothing to doubt.)*
3. How can the moisture content of grains be further increased? *(Answers will vary. One possibility would be to serve them in broth—for example, rice or noodles in chicken soup.)*

Experiment 13:

Heat & Protein Coagulation

Purpose

This experiment demonstrates the effect of cooking time on the coagulation of protein (eggs).

Food for Today Reference

Chapter 26, "Cooking Methods."

Procedure Hints

This experiment will take two days. The first day, students will prepare and bake the custard. They will probably have time to remove the first three samples. After class, at the end of 60 minutes, remove the final sample. Refrigerate all custard samples until the next day. Students can complete the experiment then, making observations, filling in the chart, and drawing conclusions.

Important: Caution students not to taste undercooked samples, because salmonella bacteria may be present.

There are many variables that can affect the outcome of the experiment. The timing in the experiment is based on using cold ingredients just removed from the refrigerator. If the ingredients are at room temperature, the mixture may cook more quickly. If too much sugar is used, the custard will have to bake longer. The water poured into the baking pan should be very hot but not boiling. Boiling water will overcoagulate the protein, resulting in a porous structure.

Expected Results

Samples A (20 min.) and B (35 min.) will be undercooked. Sample A may still be liquid, while B may be only slightly runny. Sample C (40 min.) should be properly cooked with good appearance, texture, and flavor. Sample D (60 min.) will be darker in color, dry, porous, and perhaps tough around the edges.

"Conclusions" Answer Key

1. C—40 min. It is coagulated and firm without being over- or undercooked.
2. C—40 min. It is coagulated and firm without being over- or undercooked.
3. Answers will vary depending on personal preference.
4. Answers will vary depending on personal preference.
5. A—20 min., which may not even have started to set, and possibly B—35 min., which may be slightly runny.
6. A. It is undercooked.
7. Egg mixtures must be cooked carefully to avoid under- and overcooking; can evaluate recipes more easily; can solve problems when cooking egg mixtures.

Discussion

1. If you were baking custard for a dessert and wanted to prepare the entire meal in the oven, what other foods would you serve? *(Foods that could bake at the same temperature, such as meat loaf and broccoli casserole.)*
2. Discuss the relationship between cooking egg mixtures until done and the problem of salmonella bacteria in eggs. *(Because of the presence of salmonella in some raw eggs, egg mixtures should be cooked thoroughly but not overcooked so that the protein toughens.)*
3. Where else is custard used besides in desserts? *(Quiche, a custard base with different foods added, such as cooked meat, cheese, vegetables. Discuss different kinds of quiche.)*

Experiment 14:

Fresh or Not? That is the Juice Question!

Purpose

In this experiment, students conduct a blindfold test to judge fruit juice by smell, taste, and touch.

Food for Today Reference

Chapter 5, "Nutrients at Work."

This experiment may also be used with Chapter 8, "Vitamins & Minerals"; Chapter 10, "Nutrition Guidelines"; and Chapter 30, "Fruits."

Procedure Hints

You may want to use this experiment as an introduction to food science. It will give the students experience in making sensory evaluations. As a result, students may find it easier to evaluate the products in subsequent experiments.

Use blindfolds the students feel comfortable with, such as cloth napkins or dish towels. Or students may be asked to bring their own blindfolds, such as large handkerchiefs or scarves.

Remind the Assistants to place cups securely into the Judges' hands, since Judges will not be able to see them.

After each pair of students has completed three trials of the taste test, you may want to repeat the entire experiment. This time have students switch places, with the Assistants acting as Judges.

Results from all the Judges can be tabulated, if desired, to determine what percentage preferred each juice.

Expected Results

Results will vary depending on personal preference.

"Conclusions" Answer Key

All answers call for personal opinion and will vary.

Discussion

1. Why is it difficult to judge sensory characteristics objectively? *(People have their own ideas and likes and dislikes. Also, sensory characteristics cannot be measured like height or weight can.)*
2. Why does industry use taste-testing panels? *(Product must appeal to largest possible number of consumers; taste-testing helps them to make improvements.)*
3. What other foods would you like to taste-test in the same manner? Why? *(Answers will vary.)*

NOTE: You may wish to have the students begin their "Food Science Journals" with this experiment. Explain the concept of publishing the results and tell students it is an important part of completing an experiment. Students may wish to keep a separate notebook for their Food Science Journals.

Experiment 15:

What Role Does Smell Play in Taste?

Purpose

In this experiment, students conduct a taste test to observe the ability of subjects to taste without the use of the sense of smell.

Food for Today Reference

Chapter 28, "Creative Additions."

Procedure Hints

You may want to use this experiment as a companion to Experiment 5, which explores the use of all the senses except for sight. Begin by asking students how much of the sense of taste, if any, is actually accounted for by smell.

Reveal to student subjects that they will be fed samples of food during the experiment and that they are to follow instructions exactly as given. Note that some of the subjects will additionally be asked to pinch their nostrils closed during a portion of the experiment. Point out to all parties involved that the success of the experiment depends on its being carried out under rigorous laboratory conditions.

Expected Results

The absence of the sense of smell will have a direct bearing on all the foods, but especially those (such as pudding) that are characterized as "flower" on the scale of primary odors. For some students, foods with textural similarities (for example, peanut butter and margarine, or pudding and mayonnaise) may seem to be a single food.

"Conclusions" Answer Key

1. Answers will vary among respondents and from one group of subjects to another.
2. Answers will vary as noted above.
3. Answers should indicate that similarity in texture played a significant role. Note that "mouth feel," a sensory quality relating to texture, is an important aspect of evaluating food.

Discussion

1. Apart from its role in tasting, why is smell important? *(It is a natural form of protection, the importance of which can be seen in such critical situations as the ability to smell smoke—signaling fire—or the ability to tell if milk has turned sour.)*
2. What foods besides those tested in the experiment would be especially hard to identify in the absence of smell? *(Answers will vary but might include foods with a flowery or sweet primary odor.)*
3. Find the word anosmia in a medical reference or encyclopedia. What does it mean? How is it treated? *(It is a medical condition in which the sense of smell is nonfunctional. There is no treatment at present, although some scientists are experimenting with the effectiveness of minerals such as zinc in helping improve this condition.)*

Experiment 16:

Emulsification—A Saucy Mix-Up

Purpose

In this experiment, students test the ability of prepared mustard to enter into an emulsion and determine whether speed is a factor in forming an emulsion.

Food for Today Reference

Chapter 35, "Eggs."

This experiment may also be used with Chapter 41, "Salads & Dressings."

Procedure Hints

Because of the fragile nature of emulsions and the precision required to make mayonnaise, this experiment has been structured around a somewhat less fragile colloid—a suspension of prepared mustard and oil. Nevertheless, before students begin, you may want to demonstrate the technique of drizzling in the oil a little at a time first, and then increasing to a stream.

You may also want to inspect the beaters and bowls before students start to be sure they are absolutely clean, grease-free, and dry. While conducting this inspection, you might use the time to remind students of the importance of proceeding with clean equipment any time beating is involved.

Expected Results

Sample A should have a smooth, even texture, while Sample B separates into its component ingredients.

"Conclusions" Answer Key

1. Students should respond that it was.
2. When the oil was drizzled, the mixture became emulsified; in order for an emulsion to form, the liquid fat must be added slowly at first.
3. Most students should agree that the emulsified dressing is more pleasing from an overall sensory standpoint.
4. The one labeled "Sample A."

Discussion

1. Why do you think even a hint of grease might interfere with emulsification? *(Grease is a form of fat, and the fat must be introduced slowly at first.)*
2. Most recipes for mayonnaise suggest starting with raw egg yolk. What health risk does this approach carry? *(Raw eggs may carry pathogenic microorganisms.)*
3. What recommendation can you make for avoiding the problem noted in the previous question? *(Answers will vary. Some students might suggest cooking the egg just long enough to prevent any health risk.)*

Experiment 17:

Smooth Sauces—Hold the Lumps

Purpose

In this experiment, students use three different methods for making a sauce thickened with flour to determine which is most effective.

Food for Today Reference

Chapter 43, "Soups, Stews & Sauces."

Procedure Hints

Allowing the samples to stand while the next variation is prepared may affect texture. For more consistent observations, you may want to have the students complete their observations of one sample before preparing the next variation.

If time is short, you may want to have each lab group prepare only one variation. Adjust the supplies for each group accordingly. Have students circle their assigned variation on the Observation Chart. When the experiment procedures have been completed, have students share their observations on ease of mixing. Let each student observe all three samples for texture and flavor. *Caution:* Be sure a clean spoon is used each time a sample is tasted.

Expected Results

Sample "B—Hot Water" may be a little difficult for the students to mix. Lumps may form. Adding flour to cold water (A) or melted fat (C) should produce a smooth mixture.

"Conclusions" Answer Key

1. C, because the melted fat best separates the starch granules and prevents them from clumping together and forming lumps.
2. B. The flour formed lumps in the hot water and it was difficult to eliminate them. The stirring process was considerably longer.
3. C should be the smoothest.
4. The sauces should have the same flavor, but students may prefer C.
5. A or C, which produced more satisfactory results, are likely choices.

Discussion

1. Where else would you use flour as a thickener besides in making a sauce? *(Soups, gravies, puddings.)*
2. What could you do if the sauce was lumpy? *(Try to beat the lumps out; strain out the lumps and add more flour, if necessary, to make it thicker.)*
3. What could you add to the sauce to give it more flavor or a different flavor? *(Seasonings, grated cheese.)*

Experiment 18:

Kneading It—Effects on Quick Breads

Purpose

This experiment demonstrates the effect of overmixing muffin batter, resulting in overdevelopment of gluten.

Food for Today Reference

Chapter 44, "Baking Basics."

This experiment may also be used with Chapter 45, "Quick & Yeast Breads."

Procedure Hints

You may wish to prepare correctly mixed muffins ahead of class so students have a standard to which they can compare their products.

Muffin batter must be stirred only long enough to moisten the dry ingredients. If the batter is overstirred, gluten will overdevelop, resulting in tunnels and a coarse, tough texture.

Have students count strokes accurately. Remind students that the batter will be lumpy in some variations. Students often want to stir until the batter is smooth, like cake batter.

Expected Results

The muffins from batter that was stirred 18 strokes (B) and 30 strokes (C) will be overmixed. Overmixed muffins have peaks and tunnels, uneven shape, and tougher texture. The tops will be smooth rather than lumpy.

"Conclusions" Answer Key

1. The extra stirring overdeveloped the gluten, which made it difficult for the gases from the baking powder to escape, creating tunnels or holes inside the muffin.
2. Decreased quality. It created a product with a smooth but tough crust. The inside was coarse and tough, with tunnels and holes. The muffin was not evenly browned.
3. The one that was mixed the least (A), because the gluten was not overdeveloped.
4. To create a good muffin, don't stir the batter any more than absolutely necessary to moisten the flour. Scoop the batter gently into muffin cups.
5. Any baked product using the muffin method should be mixed the same way—with the least amount of stirring. Can evaluate mixing methods in recipes and solve own baking problems.

Discussion

1. How did you feel baking a batter that was lumpy rather than smooth, like cake batter? *(Probably wanted to stir more.)*
2. What have you learned from this experiment? *(Importance of following mixing directions.)*
3. What personal characteristic must you use when working with mixtures involving gluten? *(Judgment—the amount of gluten development varies with the kind of product desired. All batters and doughs cannot be mixed the same way—it depends on the amount of gluten that must be developed. Must judge the correct amount of mixing to achieve desirable results.)*

Experiment 19:

Kneading It Too—Effects on Yeast Breads

Purpose

In this experiment, yeast dough is kneaded for two different time periods to determine the effect of kneading on gluten development.

Food for Today Reference

Chapter 44, "Baking Basics."

This experiment may also be used with Chapter 45, "Quick and Yeast Breads."

Procedure Hints

This experiment takes two days. On the first day, the dough is prepared, kneaded, and refrigerated. It is baked the next day and observations are made. If the class period is too short, the experiment may have to be extended to a third day so the bread will have time to cool before being cut. Warm bread is difficult to cut, which could affect the grain and structure of the slice.

While it's difficult to overknead yeast dough by hand, it can be done easily with a mixer or food processor. If you have a mixer with a dough hook or a food processor, you may want to add another version, using the appliance to overknead yeast dough so students can see what happens.

Expected Results

Sample B, kneaded 8-10 minutes, should have the best characteristics and flavor.

"Conclusions" Answer Key

1. B
2. Answers will vary.
3. B should be easier to chew because gluten developed, allowing bread to rise. A is compact and hard because there was not enough leavening action.
4. B, but answers may vary.
5. Follow kneading instructions when making bread.

Discussion

1. What shortcuts can be taken to cut down on kneading time? *(None if kneaded by hand; can use mixer with dough hook or food processor.)*
2. Describe a yeast dough that has been kneaded for the proper length of time. *(It will be silky smooth, elastic, and will be easily formed into a ball; small gas bubbles will be visible on the surface.)*
3. How does the time dough is kneaded relate to the kind of product desired? *(If the purpose is just to mix ingredients, like biscuits, dough is kneaded only a brief time. If more gluten development is wanted, dough must be kneaded longer.)*

Experiment 20:

Substituting the Sugar—Does It Work?

Purpose

This experiment tests the effects of sugar substitutes on shortened cakes. One sample is made using sugar as directed in the recipe; a second is made with a sugar substitute that contains saccharin; and a third is made with a sugar substitute that contains aspartame. Samples are compared to determine whether artificial sweeteners are a valid alternative in baked goods and if so, whether one type is better than another for baking.

Food for Today Reference

Chapter 3, "The Food Supply."

This experiment may also be used with Chapter 20, "Food Safety & Storage"; Chapter 46, "Cakes, Cookies & Candies."

Procedure Hints

For this experiment, you will need two types of artificial sweeteners: one that contains saccharin and one that contains aspartame. (Aspartame is the major ingredient in various NutraSweet® products.) The amounts recommended may vary according to the products you use. Read the directions on the label carefully and revise the amounts if necessary so that the amount used is the equivalent of ½ cup of sugar.

Arrange a “taste-testing area” for the final products of each group. Be sure students label the serving dishes properly so that everyone knows which sample is which.

Expected Results

Sample A is the control for this experiment and should turn out correctly. Sample B will be sweet enough, but may not rise as high as Sample A. Sample C will not be nearly as sweet as the other two, and it may not rise correctly.

“Conclusions” Answer Key

1. The texture of Sample A should be light and consistent, and it should taste sweet but not too sweet. The texture of Sample B may be a little denser if it did not rise properly. Sample B is sweet, but may have a slight bitter aftertaste. The texture of Sample C may be dense if it did not rise properly. It will not taste as sweet as the other two samples.
2. Aspartame is not recommended for use in baking because it loses its sweetness when it is baked in a hot oven.
3. Whether it was meant for use in baking; the taste and texture of the final product; any warnings or health hazards the sweetener might have.
4. Answers will vary.

Discussion

1. If you wanted to use a specific brand of artificial sweetener in a cake, but the label did not say whether the product could be used in baking, how could you tell whether it could be used in a cake? *(Look at the ingredients list. If the sweetening ingredient is saccharin, the sweetener is probably okay for use in a cake; if the ingredient is aspartame, it probably is not okay.)*
2. In what other types of baked goods might you want to substitute an artificial sweetener for sugar? *(Answers will vary; the results would be similar for most sweetened baked goods.)*
3. What other ingredients—besides artificial sweeteners—could you use to add sweetness to baked products? *(Answers will vary; honey could be used, as well as sweet fruits.)*

Experiment 21:

On the Rise—Shortened Cakes

Purpose

In this experiment three variations of a simple cupcake recipe are prepared to determine how chemical leavening agents affect shortened cakes.

Food for Today Reference

Chapter 46, “Cakes, Cookies & Candies.”

This experiment may also be used with Chapter 44, “Baking Basics.”

Procedure Hints

For optimum results, the three samples should be baked together in the same pan. If time permits, all three variations could be prepared by the same group and baked together. (Adjust supplies for each group accordingly.) If not, assign each group the variation they are to prepare as specified on the experiment worksheet.

The version using baking soda and cream of tartar must be prepared last and the pan must be placed in the oven immediately. As soon as the baking soda and cream of tartar are mixed with liquid, the chemical reaction begins. If too much time elapses before the batter is placed in the oven, most of the carbon dioxide will have escaped before the heat can set the structure of the cupcakes. The cupcakes will not rise much.

Expected Results

Samples A (1 tsp. [5 mL] baking powder) and C (cream of tartar/baking soda) should produce similar products if C was placed in the oven immediately after mixing. If too long a time elapsed, C may not rise as much as the others. B (3 tsp. [15 mL] baking powder) may collapse slightly because it rises too fast, not giving the heat enough time to set the structure before the carbon dioxide dissipates. It will also have a coarser grain. Those with sensitive taste may also detect a slightly unpleasant metallic flavor in B.

“Conclusions” Answer Key

1. Probably A or C. Tender, fine texture; better flavor.
2. All should rise, but B may collapse slightly. C may not rise properly if it is not put in the oven immediately.
3. Baking soda, to balance the acid in the buttermilk.
4. Normally, should be no difference if other factors are the same and if baking soda mixture is baked immediately.
5. Answers may include: mixing, oven temperature, amount of batter in the pan.

Discussion

1. Under what conditions would you use baking soda/cream of tartar instead of baking powder? *(If called for in recipe—many older recipes use it—or as a substitute if baking powder is not available. However, the substitution may affect product quality.)*
2. Discuss the differences in texture in the three different samples. *(B should be coarser and may contain tunnels. A and C should be tender with a fine grain.)*
3. Which cupcakes had the best flavor? Why? *(A and C should have the best flavor. Extra baking powder in B might give a slightly unpleasant metallic flavor.)*

Experiment 22:

The Pectin Question

Purpose

This experiment determines the effect of pectin and sugar in making jelly.

Food for Today Reference

Chapter 29, "Preserving Foods at Home."

This experiment may also be used with Chapter 30, "Fruits."

Procedure Hints

To conduct the complete experiment, at least three lab groups are needed. Assign each group the variation they are to prepare as specified on the experiment sheet. If it is not possible to have three lab groups working at one time, adapt the experiment by extending it over more than one class period.

Use plain white bread to test spreadability and flavor of the jelly. Because it's so bland, it will not influence the flavor. Its softness will test the spreadability of the jelly.

Expected Results

Sample B should produce an acceptable jelly. A (no pectin) and C (extra sugar) should rate lower in consistency and spreadability because they will not gel properly. Flavor preferences may vary, but students may feel that C (with extra sugar) is too sweet.

"Conclusions" Answer Key

1. A (no pectin) did not gel; B (1 cup [250 mL] sugar) gelled properly; C (2 cups [500 mL] sugar) gelled but not as well as B.
2. Pectin needs the right amount of acid to gel. The amount of sugar must balance the amount of pectin and acid. Too much or too little sugar creates a weak gel or prevents the gel from forming.
3. Should be B (pectin + 1 cup [250 mL] sugar). It had the best gel.

Discussion

1. What is the purpose of pectin? *(Pectin, a natural substance present in many fruits, has gelling ability when cooked. It causes fruit juice or fruit mixtures to gel so they can be easily spread on bread.)*
2. Why must jams and jellies be processed in hot water? *(To destroy harmful microorganisms that might make it spoil.)*
3. How did people make jams and jellies before the invention of commercial pectin? *(Fruits high in pectin, such as apples, were added to the mixture. Jams were cooked until enough moisture evaporated to obtain the correct sugar and pectin concentrations.)*

Experiment 23:

Bacteria in Numbers—Clean Hands

Purpose

To develop an awareness of bacteria growth from individual hand samples.

Food for Today Reference

Chapter 20, "Food Safety & Storage."

Procedure Hints

You may want to use this experiment with Experiment #1 which deals with cleanliness and sanitation to deter foodborne illness. Reiterate the need for soap. Encourage a discussion about healthy habits.

Expected Results

Petri dishes will show the kind of bacteria that can grow—and how important hand washing is to the maintenance of good health.

"Conclusions" Answer Key

1. Answers will vary. They should have had good scrapings.
2. Yes. Students may have a variety of answers. Answers will vary.
3. Answers will vary. Students will probably expect to have seen some kind of bacteria growing.
4. A more careful approach to hand washing. A standard 20-second scrub.

Discussion

Go through *Extra Ideas*:

- Try the 20-second scrub and then try the experiment again with another.
- Repeat the 8 steps under "Procedure" and record your findings.
- Try the experiment with wiping door handles at school. Repeat the 8 steps under "Procedure" and record your findings.
- Develop a list to reduce bacterium in the school and at home. Share your list with the class.
- Research other substances that promote bacteria growth (like agar). List your findings.
- Develop a different observation chart for your experiments. Ask: would you include? Encourage students to share their samples with classmates.
- Discuss how you can help minimize the likelihood of any foodborne illness. Participate in a discussion with your class regarding safe and sanitary procedures.
- Have students produce a drawing of the 20-second hand scrub. Post your drawing in the school cafeteria. Ask that all of the class drawings be posted somewhere in the school building.
- Have students do the experiment with their dog or cat. Have them bring in results from home.

Experiment 24:

Clear That Broth

Purpose

To observe the magnet-like effect of egg whites as they attract particles from a clouded broth.

Food for Today Reference

Chapter 35, "Eggs."

Procedure Hints

Have ingredients all prepped for the activity. Have bones roasted prior to class.

Expected Results

A clear soup with good flavor.

"Conclusions" Answer Key

1. Yes. Answers will vary.
2. Yes. Very easy to remove.
3. All clear. First cloudy, now clear. Answers will vary. They should think the broth is tasty.

Discussion

Go through *Extra Ideas*:

- Encourage students to try this experiment with a beef stock or broth.
- Encourage students to try this experiment with a vegetable stock or broth. Discuss the differences.
- Will this experiment work with whole eggs? Answer —No.
- Freeze ice cube trays with clear stock (these can be added for flavor in stock and sauces).
- Roast beef, veal, lamb, chicken or buffalo bones in the oven before adding to broth (they will add a rich deep flavor). Discuss with students the richness in flavor that roasting provides.

Experiment 25:

Hold That Curdle

Purpose

To observe what happens when cooking a recipe with milk and cream at too high a temperature.

***Food for Today* Reference**

Chapter 34, "Dairy Foods."

Procedure Hints

Have ingredients all prepped for the activity.

Expected Results

A cooked milk product without curdling.

"Conclusions" Answer Key

1. Yes; yes. Answers will vary.
2. Answers will vary. Depends on the time factor, ingredients and technique
3. Answers will vary.
4. Answers will vary.

Discussion

Go through *Extra Ideas*:

- ◆ Make a list of foods that have intentional curds. Bring in a sample. Determine the popularity of curd laden foods. Are these foods most high school students find interesting? *(No.)*
- ◆ Find at least one reference to "curds" in a song, a nursery rhyme, or a children's story.
- ◆ Develop an experiment of your own. Prepare it in the same form as in Experiment #25.
- ◆ Prepare oven-baked custard. What were your observations? *(Answers will vary.)* Hold a class discussion on this topic.
- ◆ Prepare the milk (do not drink it). Add a tablespoon of salt while it is warming.
- ◆ What happens to the milk? *(It will vary.)*
- ◆ Do some research on fresh pineapple—it contains a curd-creating property. What is that enzyme called? *(Bromelin.)*
- ◆ Prepare several vegetables in separate saucepans that are filled with milk. Which of the vegetables caused the milk to curdle? *(Answers will vary.)* Which ones did not? *(Answers will vary.*

Conducting Food Science Experiments

Food science laboratory experiments differ from food preparation laboratory activities. Rather than trying to produce a standard food product, you will be investigating ingredients and cooking methods. By observing what happens in each experiment, you will learn the effects of the various ingredients and methods used.

Most experiments involve several variations that allow you to make comparisons. These variations are achieved by substituting different ingredients (variable substances) or by using different preparation or treatment methods. Many of the variations will not produce a standard food product. These "failures" will help you understand the specific scientific principles that underlie successful food preparation.

Many experiments include a control sample. A *control* is the standard in an experiment with which other samples are compared. For example, suppose an experiment calls for adding an acid to milk. An untreated sample of milk serves as the control to which the treated samples are compared.

The experiments are designed to follow scientific laboratory procedures. As in any laboratory work, you will need to follow standard safety and sanitation procedures at all times.

The Experiment Worksheet

Before beginning an experiment, read the experiment worksheet carefully. Make certain you understand what you are to do. Ask questions, if necessary.

The worksheet begins with an objective, which states the purpose of the experiment. Next you will find scientific terms with their definitions. Under "Text Reference" you will find specific chapters and sections in *Food for Today* where you can find basic information that will help you understand the experiment. "Background Information" gives you additional explanation and an overview of the experiment. Next you will find a list of supplies. Use the check-off blanks to be sure you have everything you need for the experiment.

Procedure

Under "Procedure," the worksheet gives you step-by-step directions for conducting the experiment. Each step is numbered and has a check-off blank. Check off each one as you do it so you don't miss any steps.

Follow the directions carefully. Measure accurately. Mix each sample exactly the same way, unless the directions state differently. Otherwise, you won't get the proper results.

If you must use the same equipment for several parts of the same experiment, wash it carefully before you proceed with each part. For example, if you are doing two variations—one involving baking soda and the other vinegar—you must be sure that the measuring spoon is free of any baking soda before measuring the vinegar. Otherwise, the residue of baking soda, even if it is only a small amount, can affect the outcome of the vinegar variation. This is called *cross-contamination*—one substance is accidentally introduced into another part of the experiment.

Label the containers for the variations carefully at each step so you don't get them mixed up. Following instructions carefully for labeling will help you make more accurate observations.

A pencil or nontoxic waterproof marker is recommended for labels that are placed on the edges of plates and that might accidentally be moistened. Ordinary pens usually smear when wet, making it difficult to read the label.

Observations

Experimental work is valuable only when a written record is kept of the data and observations. Your observations will be written on an Observation Chart, which is part of the experiment worksheet.

Most of the observations made in these experiments are sensory—using senses such as seeing, smelling, feeling, and tasting. At times you will also be asked to make some simple objective observations, such as measuring the height of a sample. Science laboratories use scales, microscopes, and other special equipment to evaluate the characteristics of foods. Such observation methods are beyond the scope of these experiments.

When you are asked to measure height or length, use a ruler and record your measurements in metric units (centimeters) as well as standard units (inches). Metric measures are used by scientists.

Write your observations as single words or brief phrases in the correct row and column on the Observation Chart. If you change your mind as you begin to compare the variations, cross out your first impression and write in the new one. Never erase anything you write on the Observation Chart. Your first impressions may become useful as you reflect on the results of your experiment.

In writing your observations, be as specific as possible. Avoid general descriptions such as "good," "bad," or "nice." Specific descriptive words or phrases such as "musty," "large tunnels," "flaky," or "curdled" will make it easier to compare the results of your experiment with your classmates. Your teacher will provide you with examples of words you can use in describing your observations.

Pay close attention to detail when you make your observations. Here are some guidelines to help you make specific kinds of sensory observations:

- **Aroma.** To test the aroma of a product, place it at a distance of 4 to 6 inches (10-15 cm) from your nose. If the aroma is faint, direct it toward your nose by fanning the air in one direction from the product toward your nostrils. *Never* place the product directly under your nose. Although the products and chemicals used in these experiments are not toxic or harmful, you could accidentally take a deep breath of something that smells very unpleasant. In a scientific laboratory, this is even more important, since a moderate to severe chemical burn could result from sniffing the chemicals.
- **Flavor.** Have the sample at an appropriate temperature. If food is too hot or cold, you may not be able to taste it as well. When tasting, put a small amount of the product on your tongue. Then move the food around in your mouth so that it reaches all parts of your tongue. Taste buds are located mainly on the sides and back of the tongue. To sense the flavor as fully as possible, make certain the food reaches the parts of the tongue with the most taste buds. Chew solids until they liquify. When you are tasting more than one sample, take a sip of water or rinse your mouth after tasting. This will remove the flavor of the sample before you taste the next sample. **CAUTION:** Never attempt to taste a product unless you are specifically instructed to do so. Although the ingredients used in these experiments are nontoxic, tasting some food substances can result in an unpleasant experience. In scientific laboratories, where hazardous and toxic chemicals are often used, tasting is absolutely forbidden. Do not attempt to observe samples in your science laboratory by tasting them.
- **Appearance.** Look at the product closely to note shape, texture, and color. Cut solid products so you can examine the inside. When cutting, use a sharp knife and a cutting board. Cut with a back-and-forth sawing motion. If the product is a liquid, put a small amount on a spoon or plate so that you can examine it more closely.
- **Texture.** You can determine texture by looking at the product and examining details, feeling it with the fingers, or sensing it in the mouth. How does it feel when you bite into it?

Conclusions

Once you have made your observations, you will make conclusions regarding the results of the experiment. Answer the questions listed in the "Conclusions" section of your worksheet. Since all the conclusions are based on your personal observations, your answers may vary from those of your classmates. If the results of your experiment are not what you expect, the difference may be in the way you conducted the experiment. By analyzing your procedures and results, you may find out why your experiment did not turn out as you expected. What might you do differently if you performed the experiment again?

You will be asked to explain the practical application of the experiment. How can you use the information in your daily life? Will it make you a better shopper? Will it help you prepare better meals or become a better manager? Will it improve your decision-making skills?

Extra Ideas

This section of the experiment worksheet gives you suggestions for finishing the experiment and using the samples you created. Remember that cleanup is also part of finishing the experiment.

The "Finishing Up" section also suggests a method of publishing your results, usually by making an entry in a Food Science Journal. The results of many of these experiments will help you solve problems and analyze recipes in the future. It is therefore a good idea to keep a neat, well-organized Food Science Journal—you will be creating a valuable reference tool for yourself.

Name ______________________ Date ____________ Class ____________

Laboratory Safety & Accident Prevention

To prevent falls...

1. Wipe up all spills at once.
2. To reach items stored in high places, use a sturdy stepstool or ladder.
3. Close cabinet doors and drawers.

To prevent cuts...

1. Keep sharp knives sharp. They are less likely to cause an accident than dull ones.
2. Use a cutting board.
3. Cut away from you with the knife blade slanted.
4. For peeling vegetables such as carrots or potatoes, use a peeler instead of a knife.
5. If a knife, kitchen scissors, or ice pick starts to fall, get out of the way. Do not try to catch it in mid-air.
6. Wash, dry, and store knives separately from other dishes and utensils.
7. Keep your fingers away from beaters and blades in appliances.
8. Use knives and other sharp tools only for their intended purpose.
9. Sweep up broken glass immediately.
10. Wrap your hand in a towel to pick up broken glass.
11. When opening cans, cut the lids completely off.
12. Don't leave sharp knives in a sink full of water.

To prevent fires and burns...

1. Use salt or baking soda, *not water*, to put out a grease fire.
2. Keep flammable materials away from the top of the range and away from portable appliances that produce heat.
3. Use a dry potholder to remove pans from the range.
4. Store flammable substances such as aerosol sprays away from heat sources.
5. Use a metal trash can when disposing of hot or smoldering items.
6. Keep the range exhaust hood and ducts clean.
7. Keep pan handles turned inward on the range.
8. When removing a pan lid, tilt the lid away from you and do not hold your face directly over the pan.
9. When removing a pan from the oven, pull the rack out. *Don't* reach into a hot oven.
10. Wear an oven mitt on each hand and use both hands to remove pans from the oven.
11. Check to be sure all appliances are turned off when you are finished with them.
12. Use a spoon or tongs, *not your fingers*, to remove food from hot liquid.
13. When lighting gas burners with a match, strike the match first, then turn the burner on.
14. If you smell gas, turn off all range and oven controls and tell your teacher.

To prevent electric shock...

1. Read appliance booklets before using appliances.
2. Keep electrical cords away from water and hot objects.
3. Do not plug several cords into an electrical outlet at one time.
4. Unplug portable appliances after you have used them.
5. Disconnect appliances before cleaning them. Do not put them in water unless the appliance is labeled "immersible."
6. Before using an appliance, make sure your hands are dry and that you are standing on a dry surface.
7. Unplug appliances before bringing metal objects in contact with any working parts.
8. Plug the cord of portable appliances into the appliance first, then into the wall.

To prevent microwave accidents...

1. Never use a microwave if the door appears damaged.
2. Never turn on the microwave if there is no food inside.
3. Do not heat sealed jars, cans, or bottles in the microwave.
4. Do not heat home-canned foods in the microwave. Use a conventional range.
5. Use potholders to remove food containers from the microwave.
6. Remove lids and plastic wrap carefully to avoid steam burns.
7. Distribute the heat by stirring microwaved foods before serving them.

(Continued on next page)

Food Safety Procedures

1. Place books, purses, and other personal items in an area of the classroom not used for food preparation.
2. Wear appropriate, clean clothing on lab days. Avoid long, loose sleeves, sashes, and dangling jewelry.
3. Wear a clean apron.
4. Pull hair back and secure it so that it stays away from your face and shoulders.
5. Avoid working with food if you have an open wound on your hands.
6. Wash your hands with soap before beginning the lab. Dry your hands on paper towels or on cloth towels not used for drying dishes.
7. While working with food, avoid touching your hair, skin, face, or other unclean objects.
8. Repeat hand washing when necessary—especially after coughing, sneezing, or using the restroom.
9. Be sure you have clean dish towels, dish cloths, potholders, and oven mitts before beginning the lab. Obtain additional clean items as they are needed.
10. Wipe all counter tops and tables at the beginning and end of each lab.
11. Use *hot*, soapy water for washing dishes.
12. Wash dishes, pans, and utensils as you use them, allowing them to dry on the drain board when possible.
13. When tasting foods, use a spoon other than the one used for stirring. Use a clean spoon for each person tasting and for each time food is tasted.
14. After working with raw animal foods, scrub all areas and utensils used with hot soapy water.
15. When possible use a kitchen tool, *not* your hands, to complete tasks.
16. Thoroughly cook foods to be served hot. Keep them hot until they are served.
17. Foods to be served cold should be kept cold until serving time.
18. Cover leftover foods and store them in the refrigerator immediately.

Student Emergency Contact Information

Student's Name: ______________________________

List person(s) to contact in case of an emergency:

Name: ______________________ Relationship to Student: ______________

Home Address: ______________________________

Home Telephone: ______________ Work Telephone: ______________

Name: ______________________ Relationship to Student: ______________

Home Address: ______________________________

Home Telephone: ______________ Work Telephone: ______________

List any special needs (e.g., medications, allergies, disabilities, etc.):

If you cannot be located in case of serious injury to this student, indicate a physician for emergency treatment:

Preferred Hospital: ______________________________

Student and parent or guardian have read and understand the *Laboratory Safety & Accident Prevention Guidelines* as provided by the instructor. The student can identify the following:

- The fire extinguisher in our laboratory is located ______________________ .
- The fire blanket in our laboratory is located ______________________ .
- The emergency telephone number(s) for the fire department, police department, poison control center, and ambulance is ______________________ .

Student Signature: ______________________________

Date: ______________

Signature of Parent or Guardian: ______________________________

Date: ______________

Glossary of Selected Food Science Terms

Following is a list of terms and definitions that can be helpful in gaining an understanding of food science concepts. Italicized words in a definition have separate entries in this glossary. You may also wish to refer to the glossary found at the back of the *Food for Today* textbook for basic nutrition and food preparation terms.

acid. One of many *compounds* that have certain characteristics in common, including a sour taste, the ability to turn blue *litmus paper* red, and a value below 7 on the *pH scale*.

anthocyanin (an-thuh-SIGH-uh-nehn). A pigment (coloring agent) that gives red color to some plants, such as red cabbage.

bacteria (back-TEER-ee-uh). One-celled living things so small they can be seen only with a microscope.

base. One of many *compounds* that have certain characteristics in common, including a bitter taste, the ability to turn red *litmus paper* blue, and a value above 7 on the *pH scale*. Also called "alkali."

calorie. See *kilocalorie*.

calorimeter (kal-uh-RIM-uh-ter). Scientific instrument used to calculate the energy content of foods.

carbon dioxide (KAR-bun die-OX-ide). A colorless gas made of carbon and oxygen. In baked products, it is produced by some *leavening agents* and helps the product to rise.

carotene (CARE-uh-teen). Pigment (coloring agent) that gives some plants, such as carrots, a yellow/orange color. Can be converted by the human body to vitamin A.

cell. A tiny unit of living matter. All plant and animal tissues are made up of cells.

cellulose (SELL-you-lohse). Fibers that are in the *cell* walls of plants and that cannot be digested by humans.

chemical leavening (LEHV-uhn-ing) **agent.** A substance that uses a *chemical reaction* between *acid* and *base* ingredients to produce *carbon dioxide*, making baked products rise.

chemical reaction. A process in which substances are changed into different substances.

chlorophyll (KLOHR-oh-fill). Pigment (coloring agent) that gives green color to many plants.

coagulation (koh-ag-you-LAY-shun). A process in which a liquid changes into a semi-solid or solid mass.

coalesce (koh-uh-LESS). To come together, as when fat droplets come together to form globules.

compound. Two or more *elements* chemically combined to form a pure substance.

concentration. The relative amount of one substance in a certain volume of another substance.

control. The standard in an experiment with which other samples are compared.

cross-contamination. Accidentally introducing a substance from one part of an experiment into another part, possibly affecting the results of the experiment.

denaturation (dee-nay-chur-AY-shun). A change in the shape of protein *molecules*, resulting in a change in the product.

double-acting baking powder. A *chemical leavening agent* that produces *carbon dioxide* when liquid is added and again when heat is applied.

egg white foam. Beaten egg whites.

element. The simplest type of substance. All matter is made up of one or more elements.

emulsifying agent. A substance that helps two liquids form a stable *emulsion*. For example, in mayonnaise, egg yolks act as an emulsifying agent to help vinegar and oil stay evenly mixed.

emulsion. An evenly blended mixture of two liquids that do not normally stay mixed, such as oil and water.

enzymatic browning (en-zie-MAT-ik). Discoloration in fruits and vegetables; the result of an *enzyme* that causes rapid *oxidation*.

enzyme (EN-ziym). A chemical (made up of complex proteins) that speeds up *chemical reactions*.

flavone (FLAY-vone). A pigment (coloring agent) that gives white color to some plants, such as cauliflower.

gel. A semi-rigid, elastic mass consisting of liquid trapped in a network of solid particles.

gelatinization (jih-LAT-in-uh-ZAY-shun). The process that occurs when starch granules absorb liquid and swell.

gluten (GLOO-ten). The protein complex formed when wheat flour is mixed with liquid. Gives shape and structure to baked goods.

hydrogenated (high-DRAH-juh-nay-ted). Treated in a chemical process that adds hydrogen, turning oil into a solid fat.

hygroscopicity (HIGH-gruh-skop-IH-suh-tee). The ability of a substance to take up and retain moisture.

hypothesis (hy-PAH-thuh-sihs). An educated guess based on existing information.

invert sugar. A mixture of fructose and glucose (two types of sugar).

kilocalorie. The amount of heat energy needed to raise the temperature of 1 kilogram of water by 1°C; scientifically correct term for what most people call a "calorie."

leavening (LEHV-uhn-ing) **agent.** Any substance that helps a baked product to rise. See also *chemical leavening agent.*

litmus paper. Specially treated paper used as an indicator of whether a substance is an *acid* or a *base.*

microorganism (my-kro-OR-guh-niz-um). A tiny living thing of microscopic size.

mixture. Two or more substances that are physically, but not chemically, combined.

molecule. The smallest particle of an *element* or *compound* that retains all the properties of that element or compound.

osmosis (ahs-MOE-sihs). The movement of fluids through *semipermeable* membranes.

oxidation (ox-ih-DAY-shun). *Chemical reaction* in which oxygen is united with other substances.

pectin (PECK-tihn). A carbohydrate, found in many fruits, that under certain conditions can cause liquid to form a *gel.*

pH scale. A range of numbers from 0 to 14 used to measure how acidic or basic a substance is. *Acids* have a pH of 0 (strong acid) to 6.9 (weak acid). *Bases* have a pH of 7.1 (weak base) to 14 (strong base). A pH of 7 indicates the substance is neutral—neither an acid nor a base.

scientific method. A procedure used by scientists for the systematic pursuit of knowledge. The basic steps in the scientific method are: 1. state a problem; 2. form a *hypothesis*; 3. test the hypothesis by conducting experiments and making observations; 4. interpret the data; 5. draw conclusions; 6. publish the results.

semipermeable (sem-ih-PUR-mee-uh-buhl). Allowing only certain substances to pass through.

sensory characteristics (SEN-sore-ee). Qualities of food identified by the five human senses of seeing, hearing, smelling, touching, and tasting.

solute (SAWL-yoot). A dissolved substance.

solution. A *mixture* consisting of extremely small particles dissolved in a liquid.

solvent (SAWL-vunt). A liquid in which a substance is dissolved to form a *solution.*

stabilizer (STAY-buh-lie-zer). A substance that helps keep a mixture from changing chemically or physically. Also called a stabilizing agent.

theory. A proposed explanation based on scientific experiments.

xylem (ZI-luhm). The tube in the stem of a plant that transports water through the stem to the leaves.

yeast (YEEST). A microscopic, nongreen plant. When used as a *leavening agent*, produces *carbon dioxide* gas, making baked products rise.

Vocabulary for Sensory Evaluation

When you are making observations, be as specific as possible. Here are some examples of terms to help you accurately describe the quality you are evaluating.

AROMA

buttery	fruity	sour
fishy	sulphuric	herbal
spicy	nutty	yeasty
odorless	musty	lemony
burnt	flowery	rancid
Oriental	smoky	sweet
	Italian	

FLAVOR

orangy	spicy	acidic
lemony	metallic	salty
smoky	musky	stale
sour	sweet	bland
fishy	fresh	rancid
bitter	tangy	tart
buttery	flat	flavorless

APPEARANCE

foamy	smooth	separated
layered	liquid	crystallized
peaked	stiff	watery
creamy	lopsided	curdled
coarse	clear	powdery
bubbly	lumpy	tunneled
specific colors	rounded	caved in
greasy	flat	

TEXTURE

pulpy	gooey	greasy
fluffy	paste-like	airy
foamy	stiff	watery
chunky	lumpy	runny
curdled	heavy	sticky
chewy	grainy	gritty
brittle	crisp	thick
tender	tough	creamy
smooth	rough	dense
light	rubbery	elastic
spongy	crumbly	fine
oily	moist	dry
coarse	slimy	slick
mushy	soft	hard
stringy	tunneled	flaky

Name ______________________ Date __________ Class ____________

Food Science

Experiment 1

The Dry Made Moist

Objective

- To determine sensory qualities in reconstituted dried fruit, as well as the amount of water that has been reabsorbed in the process.

Text Reference

- *Food for Today*, Unit 6, Ch. 26, 29
- *Food for Today*, Unit 7, Ch. 30, 33

Look for This Term

- *reconstitution* (ree-kahn-stih-TOO-shuhn): The process of restoring to a former condition by adding water.

Background Information

Foods such as dried fruits and vegetables are a convenient and nutritious snack. These foods can be dried easily at home, which can help you save money. Produce with a specific growing season can be bought and dried when prices are low, and then consumed out of season, when prices are higher and quality is generally inferior.

One critical question that arises with respect to dried vegetables and fruits is whether they can successfully be *reconstituted*—restored to their original state by the addition of water. What sensory differences, if any, exist between these fruits and vegetables and the fresh items?

In this experiment, you will answer this question by working with two samples of the same fruit—one that has been dried and one that is fresh. You will also determine how much water is reabsorbed by the dried fruit in the process of reconstitution.

Supplies

_____ 2 fresh medium-size apples or pears, cored, peeled, and each cut into 8 slices

_____ 2-qt. (2-L) measuring cup

_____ paper towels

_____ 16 pieces of a commercial or home-dried variety of dried apple or pear

_____ 1 qt. (1 L) water

_____ kitchen scale

Procedure

_____ 1. Put the slices of fresh fruit into the measuring cup. Gently press the fruit down, taking care not to press so hard that the pieces become crushed or lose their shape. Indicate the mass in your Observation Chart. Reserve the fruit for later.

_____ 2. With a paper towel, dry out any moisture that remains in the measuring cup. Add 16 pieces of dried fruit to the measuring cup. In the appropriate place in the chart, enter the mass of the dried fruit in the column labeled “Original Mass.”

_____ 3. Add 1 quart (1 L) of water to the measuring cup. Set the cup aside. Allow the fruit to soak for 40 minutes.

_____ 4. Drain the water from the fruit; then pat the pieces dry with a paper towel.

(Continued on next page)

Observations

_____ 1. Weigh the reconstituted fruit. Record this information in your chart. Compute the amount of water reabsorbed through reconstitution. To arrive at this value, use the formula MAR (mass after reconstitution) minus OR (original mass). Record the value.

_____ 2. Compute the percent of the reconstituted sample that is water. To do this, use the following formula:

$$(\text{MWR} \div \text{MAR}) \times 100$$

OBSERVATION CHART

	Original Mass (OR)	Mass After Reconstitution (MAR)	Mass of Water Reabsorbed (MWR)	Percent of Reconstituted Mass Gained as Water
Fresh fruit				
Dried fruit				

Conclusions

1. What percentage of the reconstituted fruit was water?

2. How did the mass of the dried fruit after reconstitution compare with the mass of the fresh fruit?

3. Taste a piece of the reserved fresh fruit and a piece of the reconstituted dried fruit. What differences can you detect?

Extra Ideas

- Using the instructions for poaching in Chapter 26, poach equivalent samples of fresh and reconstituted dried fruit. How do the samples compare? Are they closer in flavor than the uncooked samples of fresh and reconstituted dried fruit?
- Poach dried fruit in a liquid of choice. Decide on the type of spices and herbs that should flavor the poaching liquid.
- Reconstitute dried mushrooms. Are they reconstituted in the same way? Why or why not?
- Add flavored tea bags to the poaching liquid. What were the results?
- Develop a recipe for a dried fruit compote. Share your recipe with your classmates.

Name ______________________________ Date ______________ Class ________________

Food Science

Experiment 2

Reduction of Snack Food Fat

Objective

- To observe the difference between the flavor of commercially packaged potato chips and homemade (baked) chips.
- To explore the possibility of fat reduction in snack foods.

Text Reference

- *Food for Today*, Unit 2, Ch. 7
- *Food for Today*, Unit 3, Ch. 11
- *Food for Today*, Unit 4, Ch. 16
- *Food for Today*, Unit 7, Ch. 31

Look for This Term

- *rancid:* Having an unpleasant stale flavor, which develops during the oxidation of fat.

Background Information

Among the suggestions in *Dietary Guidelines for Americans*, there are two recommendations that frequently go hand in hand when it comes to snack foods. These are the guidelines to choose an eating plan that is low in fat, saturated fat, and cholesterol, and to choose an eating plan moderate in salt and sodium.

Both guidelines come into play in the category of snack chips. Traditional potato chips, a prime example, are deep-fried in oil. This adds significant amounts of fat and calories to the finished product. Since most commercial potato chips are liberally salted, eating them also goes against the guideline advising moderation in the amount of sodium in one's eating plan.

Still another potential problem related to the fat content has to do with the way chips are packaged and the amount of time they spend on supermarket shelves. Foods high in fat undergo chemical changes when the fat in them has a chance to mix with oxygen. One of these chemical changes is that the food becomes rancid; it takes on an unpleasant stale flavor. Rancidity can occur if a package is not airtight to begin with or if it is damaged during transit or as a result of consumer carelessness once at the retail outlet.

Many potato chip companies have introduced *baked* potato chips and other potato products that are unsalted, processed in ways to reduce fat, or placed in smaller bags or containers to reduce serving amounts.

Another solution is to make home-baked chips. In this experiment, you will start with fresh potatoes and prepare baked potato chips. You will conclude by inviting independent tasters to taste the finished product and to compare the home-baked chips with commercially produced baked potato chip products.

Supplies

_____ 2 large potatoes

_____ baking sheet

_____ vegetable-oil cooking spray

_____ imitation salt flavoring

_____ sticky notes

_____ small bag of commercial brand of baked potato chips

(Continued on next page)

Procedure

_____ 1. Preheat the over to 450°F (230°C).

_____ 2. Scrub the potatoes, but do not peel them because the skin contains a fair share of the potato's nutrients and adds to the aroma and taste when baked.

A goal in preparing potato chips is to get the chips to have a uniform thickness so that they will cook evenly. This may be achieved by using a food processor with a slicing attachment or a mandoline (a slicing tool). Another—and more traditional approach—is to cut a thin slice off the bottom of each potato so that it sits squarely on the cutting surface and then cut each potato into even, thin strips with a sharp knife. Using either method, cut two potatoes into thin, even slices.

_____ 3. Place the slices in a single layer on a baking sheet that has been sprayed with vegetable-oil cooking spray. Lightly dust the slices with imitation salt flavoring.

_____ 4. Bake the potato chips for 45 minutes, or until they are browned and crisp. Turn the chips once during the cooking process.

Observations

_____ 1. Place the freshly baked potato chips on one plate. Attach a sticky note identifying the plate as Sample A.

_____ 2. Place the contents of the bag of baked commercial potato chips on a second plate. Mark the plate as Sample B.

_____ 3. Ask classmates to taste the two samples and to judge them according to three criteria: flavor, texture (crispness), and aroma. Indicate their responses in the Observation Chart by making hash marks in the appropriate boxes.

_____ 4. Graph the findings.

OBSERVATION CHART

	Flavor	Texture	Aroma
Homemade baked chips			
Commercial baked chips			

(Continued on next page)

Conclusions

1. According to your graph, which chips had a superior flavor? Which were crispier? Which had the better aroma?

2. Do you think you would have achieved the same result if you had compared your homemade baked chips with traditional potato chips (fried in oil)? Why or why not?

3. Do you think you would have achieved the same result if you had compared your homemade baked chips with commercial potato chips fried in a synthetic fat, such as olestra? Why or why not?

Extra Ideas

- Repeat the experiment using sweet potato slices instead of white potato slices. What difference, if any, do you observe in the cooking time? In the end product?
- Repeat the experiment using red potato slices instead of white potato slices. What difference, if any, do you observe in the appearance or taste?
- Purchase four packages of potato chips. Look closely at the packaging and make observations and comparisons. Are there differences in the packaging?
- Look on-line for snack food packaging. How many options do you find for potato chips? Are there other snack foods packaged differently? Record your findings.
- Make a list of other taproot vegetables that could be made into chips. Bake some sliced roots and share them with the class.
- Make some healthy dips to go with your experimental chips.
- Flavor your vegetable chips with herbs and spices. Is there a difference when you add fresh herbs instead of dried herbs?

Name ______________________ Date __________ Class __________

Food Science

Experiment 3

The Question of Additives

Objective

- To test for the presence of food additives in dried fruits.

Text Reference

- *Food for Today*, Unit 1, Ch. 3
- *Food for Today*, Unit 5, Ch. 20
- *Food for Today*, Unit 7, Ch. 30

Look for These Terms

- *enzymatic browning:* A chemical change caused by exposure of a fruit's flesh to the air.
- *sulfuring:* A technique in which fruits are exposed to the gas sulfur dioxide for varying periods of time.

Background Information

If you have ever cut up a piece of fruit and let it stand for a while, you may have noticed brown spots developing on the flesh. This phenomenon is a result of enzymatic browning—a chemical change caused by exposure of a fruit's flesh to the air. One easy way to avoid enzymatic browning is to coat the fruits with lemon juice or some form of ascorbic acid (vitamin C) immediately after cutting.

Food handlers in the food industry often use a different, cheaper method to retard enzymatic browning in fruit. This method—*sulfuring*, where fruits are exposed to the gas sulfur dioxide—a preservative—for varying periods of time. Because there is no way to tell if a fruit has been sulfured just by looking at it, people who prefer not to eat foods with preservatives are unaware when it comes to such foods.

In this experiment, you will test for the presence of sulfur dioxide by having the fruit undergo a series of chemical reactions. You will observe the behavior of the fruit samples and record your findings.

Supplies

_____ commercial dried fruit

_____ glass jars

_____ distilled water

_____ glass stirrer

_____ funnel

_____ cheesecloth or new, paper coffee filter

_____ hydrogen peroxide

_____ table salt

Procedure

_____ 1. Be sure all your equipment has been thoroughly washed and dried with a lint-free cloth before proceeding.

_____ 2. Place 2 to 4 pieces of one type of fruit in a glass jar. Pour in enough distilled water to cover the fruit.

_____ 3. Keep the fruit in the water for 15 minutes. Stir often. The fruit will absorb some of the water. If all the water is absorbed, add a little more.

_____ 4. Line the funnel with a thickness of cheesecloth or a new, paper coffee filter. Set the funnel over a second jar. Drain the liquid from the fruit into the lined funnel.

_____ 5. When all the liquid has drained into the jar, remove the funnel. Add ¼ cup (50 mL) of hydrogen peroxide to the strained liquid.

(Continued on next page)

Observations

_____ 1. Add approximately 1 tablespoon (15 mL) of table salt to the drained liquid, and stir. If a white solid forms, sulfur dioxide was used to preserve the fruit. If no white solid forms, sulfur dioxide was not used. Record your findings in the Observation Chart.

_____ 2. Repeat steps 1 through 5 with another fruit. Again, record your observations in the chart.

OBSERVATION CHART

Type of Fruit	White Solid (Y/N)	Sulfur Dioxide Used (Y/N)

Conclusions

1. Which fruits, if any, produced a white solid?

____

____

____

2. Which fruits, if any, were treated with the preservative? Which fruits, if any, were not? What does this reveal about each fruit?

____

____

____

3. Eating foods that have undergone enzymatic browning is harmless. What reason might manufacturers have for exposing fruits to sulfur dioxide?

____

____

____

(Continued on next page)

■ Extra Ideas ■

- Sulfur dioxide is also used to change the color of food. Raw sugar, for example, is brown, but when bleached with sulfur dioxide it becomes white. Why do you think sugar is bleached?
- Investigate the labels of food packages in the foods lab or in your home kitchen to see what additives were used in their processing. Name one or two. Learn what purposes they serve.
- Search product labels for sulfur dioxide or any other chemical whose name ends in the word sulfite.
- Use on-line research to investigate maraschino cherries. What is their connection to sulfur dioxide?

Name ______________________ Date __________ Class ____________

Food Science

Experiment 4

Check That Speed—Leavening Agents

Objective

◆ To compare the reaction speed when combining various chemical leavening agents with various liquids.

Text Reference

◆ *Food for Today*, Unit 9, Ch. 44, 45, 46

Look for These Terms

◆ *chemical leavening agent*: A substance that uses a chemical reaction between acid and base ingredients to produce carbon dioxide gas, making baked products rise

◆ *double-acting baking powder*: A chemical leavening agent that produces carbon dioxide when liquid is added and again when heat is applied

■ Background Information ■

One way to cause a baked product to rise is by using a *chemical leavening agent*. There are several different kinds of chemical leavening agents, but they all work on the same principle. The combination of an acid and base, when mixed with a liquid, creates carbon dioxide gas. Bubbles of gas add volume to the baked product.

A commonly used base is sodium bicarbonate, or baking soda. It can be used with various acid ingredients, depending on the recipe. Liquids such as vinegar, lemon juice, sour milk, or buttermilk are acids. Cream of tartar is a powdered acid.

Baking powder is a combination of acid and base in one product. One type of baking powder can be made at home by mixing baking soda with cream of tartar. A different formula is used for *double-acting baking powder*, the type that is commonly sold in this country today.

Different chemical leavening agents release carbon dioxide at different rates. The speed with which carbon dioxide is released affects the finished baked product.

In this experiment, you will conduct seven different procedures using baking soda, commercial baking powder, and a homemade baking powder. Each of these chemicals will be combined with hot and cold water. The baking soda will also be combined with vinegar. You will compare the type of reaction and how long each reaction lasts.

When conducting the experiment, do one version at a time so that you can make the necessary observations. Follow directions carefully.

Note that the dry ingredients are placed in the cup *first* and then the liquid is added. If you reverse the process, the results may not be accurate. Be sure the cups are dry before placing the chemicals in them. Even the slightest trace of moisture will begin a chemical reaction. After each use, wash and dry the measuring spoons so they are clean and dry for the next variation.

■ Supplies ■

_____ 3½ tsp. (17 mL) baking soda (divided)

_____ 1 tsp. (5 mL) cream of tartar (divided)

_____ 2 tsp. (10 mL) double-acting baking powder (divided)

_____ 3 Tbsp. (45 mL) cold tap water (divided)

_____ 3 Tbsp. (45 mL) hot tap water (divided)

_____ 1 Tbsp. (15 mL) vinegar

_____ measuring spoons

_____ 7 glass ramekins (custard cups)

_____ 7 drinking straws for stirring

_____ 7 adhesive labels

_____ waterproof marker or pencil

_____ clock with second hand (or stopwatch)

(Continued on next page)

Procedure & Observations

_____ 1. Refer to the list of leavening agents in the Observation Chart. Write the cup letter and name of each leavening agent on an adhesive label, using waterproof marker or pencil.

_____ 2. Attach one adhesive label to each of seven custard cups.

_____ 3. Line up the seven ramekins (custard cups) in the same order in which they are listed on the Observation Chart, but do not place them too close to each other.

_____ 4. Place a straw, which will be used for mixing, next to each cup.

_____ 5. Place each leavening agent, described in the Observation Chart, in the properly labeled cup. Be sure to wash and dry the measuring spoon before using it for a different substance so you do not cross-contaminate the mixtures.

_____ 6. Beginning with cup A, add the liquid indicated on the Observation Chart and stir with the straw next to the cup.

_____ 7. Time the length of the reaction and observe what happens. On the Observation Chart, record the length and a description of the reaction. Discard the straw you used for stirring.

_____ 8. Repeat steps 6-7 for cup B.

_____ Step 6

_____ Step 7

_____ 9. Repeat steps 6-7 for cup C.

_____ Step 6

_____ Step 7

_____ 10. Repeat steps 6-7 for cup D.

_____ Step 6

_____ Step 7

_____ 11. Repeat steps 6-7 for cup E.

_____ Step 6

_____ Step 7

_____ 12. Repeat steps 6-7 for cup F.

_____ Step 6

_____ Step 7

_____ 13. Repeat steps 6-7 for cup G.

_____ Step 6

_____ Step 7

(Continued on next page)

OBSERVATION CHART			
Leavening Agent	**Add Liquid**	**Length of Reaction**	**Description of Reaction**
Cup A: 1 tsp. (5 mL) baking soda	+ 1 Tbsp. (15 mL) cold water		
Cup B: 1 tsp. (5 mL) baking soda	+ 1 Tbsp. (15 mL) hot water		
Cup C: 1 tsp. (5 mL) baking soda	+ 1 Tbsp. (15 mL) vinegar		
Cup D: ¼ tsp. (1 mL) baking soda + ½ tsp. (2 mL) cream of tartar	+ 1 Tbsp. (15 mL) cold water		
Cup E: ¼ tsp. (1 mL) baking soda + ½ tsp. (2 mL) cream of tartar	+ 1 Tbsp. (15 mL) hot water		
Cup F: 1 tsp. (5 mL) double-acting baking powder	+ 1 Tbsp. (15 mL) cold water		
Cup G: 1 tsp. (5 mL) double-acting baking powder	+ 1 Tbsp. (15 mL) hot water		

(Continued on next page)

Conclusions

1. Which mixture(s) produced little or no reaction?

2. Which produced the most immediate and powerful reaction?

3. Which mixture(s) were slowest in starting to react?

4. Which reaction lasted the longest time?

5. Did you observe any vapor during the reactions? How would you explain the presence of vapor?

6. What conclusions do you draw from this experiment?

Extra Ideas

- The mixtures are not usable or edible and should be discarded after the experiment.
- Publish your results by recording a summary of this experiment and your conclusions in your Food Science Journal.
- Does baking powder loose its potency over time? Research the answer. Report your findings to the class.
- Research another source for making your own baking powder. Look on-line for options.
- Prepare a recipe using both baking powder and baking soda.

Name ______________________ Date ____________ Class ______________

Food Science

Experiment 5

Interactive Vegetables/Effects of Acids & Bases

Objective

- To determine the effects of acids and bases when cooking vegetables.

Text Reference

- *Food for Today*, Unit 7, Ch. 31

Look for These Terms

- *chlorophyll* (KLOHR-oh-fill): Pigment that gives green color to many plants.
- *anthocyanin* (an-thuh-SIGH-uh-nehn): A pigment that gives red color to some plants.
- *carotene* (CARE-uh-teen): Pigment that gives yellow or orange color to some plants.
- *flavone* (FLAY-vone): Pigment that gives white color to some plants.

Background Information

For purposes of cooking, vegetables are classified according to color. Each group contains specific natural pigments, which give plants color. *Chlorophyll* gives vegetables their characteristic green color. *Anthocyanin* is responsible for the red, purple, and blue colors in some fruits and vegetables. *Carotene* gives vegetables a yellow or orange color and can be turned into vitamin A during the digestion process. *Flavone* contributes the white coloring to vegetables.

Acids or bases can be present in the water supply or added to cooking water. They can affect vegetables during cooking.

In this experiment, you will cook a vegetable in plain water (saucepan A), in water with an acid (lemon juice or vinegar, saucepan B), and in water with a base (baking soda, saucepan C). The vegetables cooked in plain water will be the control with which you will compare the other two.

Note that the cooking method used for the experiment is not the one usually recommended for cooking vegetables. For the purpose of the experiment you will cover the vegetables with liquid to make sure they are completely immersed in the cooking solutions.

Supplies

Note: One vegetable per student, directed by the teacher.

_____ 3 carrots

_____ 1 small head red cabbage

_____ 1 bunch broccoli or 1½ cups (350 mL) green beans

_____ 1 small head cauliflower or other white vegetable such as turnips, parsnips, or white onions. (Frozen vegetables may be substituted if necessary, but cooking time will be shorter.)

_____ 3 small or medium saucepans with lids

_____ water-soluble marking pen

_____ ¼ cup (50 mL) vinegar or lemon juice

_____ 1 Tbsp. (15 mL) baking soda

_____ tap water

_____ measuring spoons

_____ tongs or slotted spoon, depending on vegetable used

_____ liquid measuring cup

(Continued on next page)

_____ 3 small dishes
_____ fork
_____ 6 adhesive labels
_____ pencil or nontoxic waterproof marker
_____ timer
_____ 3 glass jars or containers
_____ large storage container
_____ cooling rack

■ Procedure ■

_____ 1. With the water-soluble marking pen, mark the saucepans on the sides: "A," "B," and "C."

_____ 2. With a pencil or nontoxic waterproof marker, write each of the following on two adhesive labels: "A—Water";
"B—Acid"; and "C—Base."

_____ 3. Place one set of labels near the rims of the small dishes. Use the other set of labels on the glass jars or containers.

_____ 4. If fresh vegetables are used, wash and clean them carefully and cut into pieces about 1 in. (2.5 cm) square. Put edible discarded pieces into storage container and save for soup. If frozen vegetables are used, be sure they are thawed enough so you can divide them.

_____ 5. Divide the vegetable you are working with into three equal portions.

_____ 6. Place each portion in a separate saucepan.

_____ 7. Add vinegar or lemon juice (acid) to saucepan B.

_____ 8. Add baking soda (base) to saucepan C.

_____ 9. Add cold tap water to each pan until the water just covers the vegetables.

_____ 10. Cover the three pans.

_____ 11. Cook on high heat, watching the pans carefully.

_____ 12. When steam begins to appear at the edges of the lid, turn the heat down to medium or medium-low so the water does not boil over.

_____ 13. Simmer the vegetables until those in pan "A" are fork-tender. Time will vary from 10-20 minutes, depending on the vegetable.

_____ 14. Remove the pans from the range. Place them on a cooling rack or a heatproof surface.

_____ 15. Carefully lift the lids from the pans so the steam flows away from you.

_____ 16. With tongs or a slotted spoon, lift the vegetables from saucepan A, let the liquid drain off, and place them on the dish labeled "A—Water." Pour the cooking liquid into the glass jar with the same label.

_____ 17. Using the same procedure, lift the vegetables from saucepan B and place them on the dish labeled "B—Acid." Pour the cooking liquid into the glass jar with the same label.

_____ 18. Lift the vegetables from saucepan C and place them on the dish labeled "C—Base." Pour the cooking liquid into the glass jar with the same label.

(Continued on next page)

■ Observations ■

_____ 1. Examine the three samples and notice their color. Record your observations in the proper blanks on the Observation Chart.

_____ 2. Smell the vegetables and note differences in aromas, if any, in the three samples. Record your observations on the Observation Chart.

_____ 3. Cut the vegetables with a *fork*. Note the differences in texture and record your observations on the Observation Chart.

_____ 4. Taste a piece of each sample. Note differences in texture and record your observations on the Observation Chart.

_____ 5. Observe the color of the liquids in the glass jars. Write your observations on the Observation Chart.

_____ 6. Pour the cooking liquid from the three glass jars into the storage container.

OBSERVATION CHART			
Vegetable cooked: ______________ **Pigment:** ______________			
Characteristics	**A–Water (Control)**	**B–Acid**	**C–Base**
Color of Vegetables			
Aroma			
Texture			
Flavor			
Color of Liquid			

■ Conclusions ■

1. Would all vegetables with the same type of color pigment as the one you cooked react the same in acids and bases? Why or why not?

____

____

____

(Continued on next page)

2. What conclusions can you reach regarding the effect of acids and bases on the texture of vegetables?

3. Which of the three methods produced the most acceptable vegetable? Why did you prefer it?

4. Of what practical use is the information you learned from this experiment?

5. When adding tomatoes to a casserole, what textures would you expect in the other vegetables in the following situations?
   a. tomatoes added with raw vegetables
   b. vegetables precooked and then mixed with tomatoes

6. How would the information you learned in this experiment help you if you lived in an area with hard water (high in minerals)?

■ Extra Ideas ■

- Research nonacidic sauces for vegetables. Prepare a recipe with a nonacidic base.
- Put any edible vegetables in the storage container, refrigerate, and use them to prepare soup.
- Publish your results by recording a summary of this experiment and your conclusions in your Food Science Journal.
- Acid slows down the cooking process—this is why beans cooked in tomato sauce take 10-20 percent more time to cook than beans cooked in a non acidic sauce. Make a list of other acidic combinations.

Name ______________________ Date __________ Class ____________

Food Science

Experiment 6

Changing Character—Caramelization

Objective

- To demonstrate the effect that browning can have on vegetables

Text Reference

- *Food for Today*, Unit 6, Ch. 28
- *Food for Today*, Unit 7, Ch. 36
- *Food for Today*, Unit 9, Ch. 46

Look for This Term

- *caramelization*: A browning reaction in sugar requiring high temperatures and either low or high acidity.

Background Information

One of the most important sensory qualities of cooked food is browning. The amount of browning in cooked animal products, such as meat, fish, and poultry, is a clue to doneness. It-also greatly enhances the appearance, flavor, and even the texture of the product.

The scientific principle responsible for browning in food is *caramelization*, a reaction in foods containing sugar and either low or high acidity that is brought about through high temperatures. All fruits and vegetables are excellent candidates for caramelization because of their ample supplies of the natural sugar fructose.

In this experiment, you will compare the sensory qualities—appearance, aroma, texture, and flavor—of two samples of a common vegetable, onions. One sample of the vegetable will be raw. The other will be cooked. You will invite independent judges to evaluate the foods in terms of their sensory properties.

Supplies

_____ safety goggles

_____ skillet

_____ vegetable-oil cooking spray

_____ 1 c. (250 mL) chopped onion

_____ rubber spatula

Procedure

_____ 1. Put on your safety goggles. Spray a small skillet with vegetable-oil cooking spray.

_____ 2. Place approximately half the onion in the skillet, and cook over medium heat.

_____ 3. As the onion pieces cook, turn them. Take note of the flecks of brown that begin to appear on the edges of the vegetable that are in contact with the surface of the skillet. These flecks are an example of caramelization in action.

_____ 4. When the onions are thoroughly browned, remove them to a plate.

_____ 5. Place the remaining uncooked onion on an identical plate.

Observations

_____ 1. Invite classmates to visually examine the two samples of onion. Describe their reactions in the first column of the Observation Chart.

(Continued on next page)

_____ 2. Have your judges respond to the two samples of onion in terms of their aroma. Record these responses in the second column of the Observation Chart.

_____ 3. Proceed in a similar fashion with the flavor and texture of the two samples.

OBSERVATION CHART					
	Vegetable	**Appearance**	**Aroma**	**Flavor**	**Texture**
Raw					
Cooked					

■ Conclusions ■

1. Which of the samples did the judges enjoy more? Did any of the judges respond more favorably to the raw onion?

____

____

____

2. Did the onion caramelize evenly over its surface? How can you explain this phenomenon?

____

____

____

3. Vegetables will not brown when exposed to certain environmental factors. One of these is moisture. Did the cooking spray act as a moistener? Why or why not?

____

____

____

4. Is sautéing the only cooking method that will yield a caramelized flavor and appearance? Explain your response.

____

____

____

■ Extra Ideas ■

◆ Try roasting onions along with several other vegetables, including carrots, sweet peppers, and sweet potato. Predict the extent that each will undergo browning. Test your hypothesis.

◆ Serve soft tacos or cheese filled quesadillas topped with remaining samples of onion.

◆ Develop two recipes utilizing caramelization techniques. Make copies for all classmates. If time allows, prepare some of the recipes.

Name ______________________________ Date ______________ Class ________________

Food Science

Experiment 7

Acids Affecting Protein

Objective

- ◆ To observe the effect of acid on liquid protein.
- ◆ Learn the word ramekin.

Text Reference

- ◆ *Food for Today*, Unit 7, Ch. 34, 35, 36

Look for These Terms

- ◆ *denaturation* (dee-nay-chur-AY-shun): Change in the shape of protein molecules, resulting in a change in the product.
- ◆ *coagulate* (koh-AG-yoo-late): To become thicker, changing from a liquid to a semisolid or solid mass.

■ Background Information ■

Denaturation means that the shape of protein molecules is changed. Denaturation can be caused by heat, freezing, pressure, irradiation, chemicals, or mechanical treatment such as beating or whipping. For example, denaturation occurs when a liquid protein, such as milk or egg white, is heated. If the heating and denaturation continue, the protein molecules will clump together. The liquid will *coagulate* to form a solid. Denaturation is the first step in the coagulation process.

In this experiment, you will add vinegar to two samples of milk and observe what happens. A sample of untreated milk will serve as a control. (Refer to Experiment 4)

■ Supplies ■

_____ ¾ cup (175 mL) milk at room temperature

_____ 3 tsp. (15 mL) vinegar, divided

_____ 3 glass ramekins (custard cups)

_____ glass measuring cup

_____ measuring spoons

_____ 3 adhesive labels

_____ pencil or waterproof marker pen

_____ clock or timer

_____ 2 spoons

■ Procedure & Observations ■

_____ 1. Mark the labels as follows: "A—Control"; B—1 tsp. (15 mL) Vinegar"; and "C—2 tsp. (10 mL) Vinegar."

_____ 2. Attach a label to the outside of each ramekin.

_____ 3. Measure ¼ cup (50 mL) milk into each ramekin.

_____ 4. Add 1 tsp. (5 mL) vinegar to the milk in ramekin B and stir.

_____ 5. Add 2 tsp. (10 mL) vinegar to the milk in custard cup C and stir with a clean spoon.

_____ 6. Observe the appearance of all three samples. Record your observations in the appropriate blanks on the Observation Chair.

_____ 7. Let samples stand 5 minutes at room temperature.

_____ 8. Observe the appearance of the samples. Record your observations in the appropriate blanks on the Observation Chart.

(Continued on next page)

______ 9. After five more minutes (a total of 10), observe the appearance of the samples. Record your observations in the appropriate blanks on the Observation Chart.

______ 10. After five more minutes (a total of 15), observe the appearance of the samples. Record your observations in the appropriate blanks on the Observation Chart.

OBSERVATION CHART			
	Appearance		
Time	**A** **Control**	**B** **1 tsp. (5 mL)** **Vinegar**	**C** **2 tsp. (10 mL)** **Vinegar**
Immediately			
5 minutes			
10 minutes			
15 minutes			

■ Conclusions ■

1. What differences did you observe in the three samples?

____

____

____

2. How can you tell if a protein is denatured?

____

____

____

3. Which sample coagulated the most?

____

____

____

(Continued on next page)

4. Find a recipe in which you could apply the knowledge you learned in this experiment. Write the recipe name and where it can be found.

■ Extra Ideas ■

- Mix the samples together and use them in a recipe calling for sour milk, such as biscuits, breads, or cakes.
- Publish your results by recording a summary of this experiment and your conclusions in your Food Science Journal.
- Research the effects of acid on proteins. List on-line results. List additional results and provide a bibliography.

Name ______________________________ Date ____________ Class ______________

Food Science

Experiment 8

The Gelatin Effect

Objective

- To test how gelatin, a stabilizer, affects a frozen dessert.

Look for This Term

- *stabilizer* (STAY-buh-lie-zer): A substance that can help keep a mixture from changing chemically or physically.
- *ramekins*: Custard cups

Text Reference

- *Food for Today*, Unit 7, Ch. 34
- *Food for Today*, Unit 8, Ch. 41, 42, 43

Background Information

Frozen desserts often include *stabilizers* such as gelatin. The gelatin soaks up water from the mixture and keeps large ice crystals from forming as the mixture freezes. This affects the characteristics of the finished product.

In this experiment, you will prepare two variations of a simple frozen raspberry dessert. One is made with gelatin and the other is not. You will compare the appearance, texture, flavor, and melting characteristics of the two samples to determine the effects of adding gelatin.

Supplies

_____ 1 pt. (500 mL) whipping cream
_____ one 8-oz. (227-g) package frozen raspberries, thawed
_____ ½ cup (125 mL) sugar
_____ 2 tsp. (10 mL) lemon juice
_____ ¼-oz. (7-g) envelope unflavored gelatin
_____ 6 Tbsp. (90 mL) cold water (divided)
_____ 3 Tbsp. (45 mL) boiling water
_____ small dish or cup
_____ two 1-qt. (1 L) freezer-safe lidded containers
_____ electric mixer with large mixing bowl
_____ liquid measuring cup
_____ dry measuring cup
_____ measuring spoons
_____ rubber spatula
_____ large mixing bowl
_____ ice
_____ 4 adhesive labels
_____ pencil or marker
_____ 2 medium mixing bowls
_____ 2 ramekins
_____ 2 spoons

(Continued on next page)

Procedure

_____ 1. Mark two adhesive labels as follows: “A—Gelatin” and “B—No Gelatin.”

_____ 2. Fasten the labels to the outside of the two freezer-safe containers.

_____ 3. With the electric mixer, whip cream and set aside. Be careful not to overbeat the cream—it will turn to butter.

_____ 4. Place thawed raspberries in a medium mixing bowl.

_____ 5. Add sugar and lemon juice to raspberries. Mix well.

_____ 6. Place half the raspberry mixture into the second medium bowl.

_____ 7. Place the gelatin in a small dish or cup.

_____ 8. Add 3 Tbsp. (45 mL) cold water to the gelatin and let it stand until softened.

_____ 9. Add 3 Tbsp. (45 mL) boiling water to softened gelatin and stir until gelatin dissolves.

_____ 10. Add the gelatin mixture to one of the two bowls of raspberry mixture. Stir.

_____ 11. Set the medium mixing bowl that contains the gelatin-raspberry mixture in a large mixing bowl filled with ice until the mixture thickens to the consistency of honey. (Do not let the mixture gel.)

_____ 12. Fold in one half of the whipped cream.

_____ 13. Pour the mixture into the freezer container labeled “A—Gelatin.” Place lid securely on container.

_____ 14. Add 3 Tbsp. (45 mL) cold water to the other raspberry mixture.

_____ 15. Fold the remaining whipped cream into the raspberry mixture.

_____ 16. Pour the mixture into the freezer container labeled “B—No Gelatin.” Place lid securely on container.

_____ 17. Freeze both containers overnight.

_____ 18. The next day, mark two adhesive labels as follows: “A—Gelatin” and “B—No Gelatin.”

_____ 19. Fasten the adhesive labels to the outside of two ramekins.

_____ 20. Remove the two freezer containers from the freezer.

_____ 21. Spoon a small amount of the dessert from the container labeled “A—Gelatin” into the custard cup labeled “A—Gelatin.”

_____ 22. Using a clean spoon, place a small amount of the dessert from the other container into the other custard cup.

Observations

_____ 1. Observe the appearance of both desserts. Record your observations in the appropriate blanks on the Observation Chart.

_____ 2. Observe the texture of both desserts. Record your observations in the appropriate blanks on the Observation Chart.

_____ 3. Taste both desserts and note texture and flavor. Record your observations on the Observation Chart.

_____ 4. By this time, both desserts should have started to melt. Observe how they melt and how they look when melted. Record your observations in the appropriate blanks on the Observation Chart.

(Continued on next page)

OBSERVATION CHART		
Characteristics	**A Gelatin**	**B No Gelatin**
Appearance		
Texture		
Flavor		
Melting Characteristics		

Conclusions

1. Which dessert has the best appearance? What is the reason for the difference?

2. Which recipe is smoother? Why?

3. Which dessert melted faster? Why?

4. Which dessert did you prefer? Why did you prefer it?

5. What conclusions do you draw from this experiment?

Extra Ideas

- Both desserts may be eaten as snacks in class.
- Publish your results by recording a summary of this experiment and your conclusions in your Food Science Journal.
- Develop a recipe utilizing gelatin and the concepts from the experiment.
- Find out what happens when you add yogurt or sour cream to a gelatin recipe. Report your findings. Share finished product with class.

Name ______________________ Date __________ Class ____________

Food Science

Experiment 9

What Is in Baking Powder?

Objective

- ◆ To compare the leavening powers of a commercial baking powder and a variant prepared from common household ingredients.

Text Reference

- ◆ *Food for Today*, Unit 9 , Ch. 44, 45

Look for This Term

- ◆ *control*: A standard in an experiment against which other samples or variations must be compared.

■ Background Information ■

Almost every cook, professional or amateur, has a tale to tell about discovering midway through food preparation that a needed ingredient was missing. Careful planning and good management skills can minimize the likelihood of this occurrence. Fortunately, when it does arise, a knowledge of ingredient substitutions can often save the day.

In this experiment, you and a classmate will determine whether this observation holds true in the most demanding and precise area of cooking—baking. Each of you will prepare the same quick bread recipe, but with one difference. One of you will prepare the recipe exactly as shown. The other will use a leavening agent prepared from common household ingredients. Both breads will be judged in terms of their sensory and physical characteristics.

■ Supplies ■

_____ control recipe for *Quick Banana Bread* (see below)

_____ ½ tsp. (2 mL) sodium bicarbonate

_____ 1 tsp. (5 mL) cream of tartar

_____ sticky notes

Control Recipe for Quick Banana Bread

1 c. (250 mL) sugar

¾ c. (175 mL) applesauce

1½ c. (375 mL) all-purpose flour

2 tsp. (10 mL) baking powder

1 tsp. (5 mL) salt

2 tsp. (5 mL) cinnamon

1 c. (250 mL) mashed ripe banana

2 tsp. (5 mL) vanilla

2 large eggs

(Continued on next page)

Procedure

_____ 1. Mix ½ teaspoon (2 mL) of sodium bicarbonate and 1 teaspoon (5 mL) of cream of tartar in a small bowl. Set aside.

_____ 2. You and your partner are each to select one of the two variations of the quick banana bread recipe to prepare. The variations are as follows:

- Variation A: Use the control recipe. (Control is a scientific term designating a standard against which other samples or variations are compared.)
- Variation B: Use 2 teaspoons (10 mL) of the sodium bicarbonate and cream of tartar mixture in place of the baking powder as the leavening agent.

_____ 3. Preheat the oven to 350°F (180°C). Measure the ingredients for the variation of the recipe you have agreed to make.

_____ 4. Lightly coat a loaf pan with cooking spray; then dust with flour/use a product that combines this process.

_____ 5. Mix the sugar and applesauce in a large bowl. In another bowl, combine the flour and the leavening agent in your variation (either the baking powder or the sodium bicarbonate and cream of tartar mixture).

_____ 6. Add the dry ingredients to the applesauce mixture, along with the salt and cinnamon. Stir in the mashed banana and vanilla.

_____ 7. Beat the eggs slightly, and add these to the mixture in the bowl. Mix well.

_____ 8. Pour the two batters into the prepared pans. Be sure to place the pan with Variation A on the right side of the oven. Variation B goes on the left. Bake for 50 minutes or until a pick inserted in the center comes out clean.

_____ 9. Allow the loaves to cool on separate wire racks. When the pans are cool, affix a sticky note to each pan, labeling the variation.

Observations

_____ 1. Slice the completely cooled bread in half at the center point. Measure the height, and record your answer in the Observation Chart.

_____ 2. Turn the breads so that the labels are not visible. Place a pad of paper and a pencil in front of each pan. Have classmates taste each variation, and rate it from 1 to 5 in terms of appearance, flavor, texture, and moistness.

_____ 3. Enter classmates' ratings in the appropriate places in the chart.

(Continued on next page)

OBSERVATION CHART					
	Color	**Appearance**	**Flavor**	**Texture**	**Moistness**
Variation A					
Variation B					

■ Conclusions ■

1. Which loaf, if either, rose higher?

2. What differences between the two recipes, if any, were detected?

3. What conclusion can you draw about the contents of commercial baking powder? How can you justify this assumption?

■ Extra Ideas ■

- Enjoy the remaining quick bread with the entire class as a snack.
- Try making a third variation of the recipe using 1 teaspoon (5 mL) of baking powder and 1 teaspoon (5 mL) of baking soda. Is there a difference in the height or sensory qualities of the quick bread?
- Prepare an herb or spice cream cheese to use as a topping for the quick bread.
- Make a list of recipes that call for both baking powder and baking soda. Have the recipes available to share with the class.

Name ______________________________ Date ____________ Class ______________

Food Science

Experiment 10

Chemical or Physical—That Is the Question!

Objective

- To observe the different types of changes that occur when foods of different structures are permitted to interact.

Text Reference

- *Food for Today*, Unit 1, Ch. 4
- *Food for Today*, Unit 6, Ch. 26

Look for These Terms

- *chemical change*: A process in which properties of a substance change as new substances with different properties are formed.
- *physical change*: A process in which properties of a substance are altered, but the identity of the substance does not change.
- *nonreactive*: Constructed of a nonporous material not capable of inducing a chemical change.

Background Information

Every food, from the simplest substance to the most complex, has a chemical structure. Some of these structures—for example, that of table salt, or sodium chloride—are well known. So are their chemical symbols (the symbol for salt is NaCl).

Having an awareness of these structures and the kinds of changes that affect them can make an important difference when working with food. For instance, knowing that the application of heat results in a chemical change in many foods can mean the difference between a recipe's success and failure. A *chemical change* is one in which properties of a substance change as new substances with different properties are formed. Sometimes the properties of a substance are altered, but its identity does not change. When this happens, a *physical change* is said to have occurred.

In this experiment, you will observe these two different kinds of changes as they apply to the dissolving of substances. In one case, you will be able to reclaim the original substance. In the other, you will not.

Supplies

_____ table salt

_____ baking soda

_____ magnifying glass

_____ 2 small flame-proof glass dishes or bowls

_____ 4 tsp. (20 mL) water

_____ 2 glass stirrers

_____ safety goggles

_____ sticky notes

_____ 4 tsp. (20 mL) vinegar

Procedure

_____ 1. Examine a few grains of salt under the magnifying glass. Describe or draw their appearance in the column of your Observation Chart with the heading "Before Change." Taste the grains, and describe the taste in your chart.

_____ 2. Repeat step 1 with a small amount of baking soda. Record your reactions in the appropriate place in your chart.

_____ 3. Pour ¼ teaspoon (1 mL) of salt into a small flame-proof glass dish or bowl with 4 teaspoons (20 mL) of water. (Glass is important because it is a nonreactive substance—one that is not capable of causing a chemical change by itself.) Stir with a glass rod or stirrer to dissolve, observing the mixture during this process.

(Continued on next page)

_____ 4. Put on the safety goggles. Carefully heat the dish on the range top over medium heat until the liquid just boils away. Set the dish aside to cool. Place a sticky note near the bowl with the label "salt."

_____ 5. Repeat steps 3 and 4 with ¼ teaspoon (1 mL) of baking soda, but use 4 teaspoons (20 mL) of vinegar instead of water. Place a sticky note near the bowl with the label "baking soda."

Observations

_____ 1. With the magnifying glass, inspect the solid remaining on the cooled dish in which you heated the salt and water. Taste a few of the crystals. Describe their appearance and taste in the "After Change" column of your Observation Chart.

_____ 2. Observe the solid remaining on the dish in which you heated the baking soda and vinegar. **Do not taste this sample.** Record your observation.

_____ 3. To the dish containing the baking soda residue, add a few drops more of vinegar. Describe the behavior of the mixture as the solid dissolves.

OBSERVATION CHART		
	Before Change	**After Change**
Salt appearance		
Salt taste		
Baking soda appearance		
Baking soda behavior with vinegar		

Conclusions

1. How did the two solutions differ?

____

____

____

2. What was the substance that remained after the water boiled out of the salt mixture? How do you know this? What kind of change occurred?

____

____

____

(Continued on next page)

3. What was the substance that remained after the vinegar boiled out of the baking soda mixture? How do you know this? What kind of change occurred?

____

____

____

■ Extra Ideas ■

◆ How can knowing what kind of change has occurred help you rescue a sauce or an egg custard that has curdled or separated?

◆ Look at the "Ingredient Substitutions" chart on page 349 of the *Food for Today* text. Write down the substitutions that you think will cause a chemical change in food. Explain why you think this is accurate.

(Continued on next page)

Name ______________________ Date ____________ Class ______________

Food Science

Experiment 11

Clean It Up!

Objective

- ◆ To explore the effects of water temperature on the cleaning of dishware.

Look for This Term

- ◆ *cross-contamination*: In the context of food safety, occurs when contaminants are spread from one food to another.

Text Reference

- ◆ *Food for Today*, Unit 5, Ch. 20

Background Information

Kitchen cleanliness ties in to personal cleanliness. Keeping yourself clean helps keep your environment clean, too. Practicing good health habits early sets a pattern for life. Along with this experiment, Experiment #23 is important to incorporate into your daily routine.

Warm water makes oil and food scraps more fluid, and easier to release. The hotter the water, the lower the surface tension; as a result, the scraps of food are attacked. Also essential to this action, is the soap used. When the water is hot, the soap assists in forming an oil and water emulsification. Water needs this extra boost to assist in penetrating any oil. Soap molecules are an emulsifier because it shares two completely opposing components—one component is bound to water and stays away from oil. The other, is completely the opposite (one end is bound to water, the other to oil). Good old fashioned physical energy helps remove the grease quickly.

Supplies

_____ cold, warm, and hot water

_____ six dishpans filled with dirty dishes

_____ three detergents or types of soap

_____ three dirty dish samples

_____ clean dish towels

_____ large drying rack

Procedure & Operations

_____ 1. Fill each dishpan with some dirty dishes and take them to the sink.

_____ 2. Wash each dishpan filled with dishes using water only—no soap. Use cold water in one dishpan; use warm water in the second; use hot water on the third.

_____ 3. Document your observations on the Observation Chart (shown on the next page).

_____ 4. Follow the procedure in the text for washing dishes (page 282 under Cleanup Time), this time with soap. Use cold water in one dishpan, use warm water in the second; use hot water in the third.

_____ 5. Document your observations on the Observation Chart (shown on the next page).

_____ 6. Compare your findings. Which dishes were the cleanest? Place the dishes in the drying rack. Eat only from the dishes that were washed appropriately!

(Continued on next page)

OBSERVATION CHART					
Dishpan 1	**Dishpan 2**	**Dishpan 3**	**Dishpan 4**	**Dishpan 5**	**Dishpan 6**
Observations:	**Observations:**	**Observations:**	**Observations:**	**Observations:**	**Observations:**

(Continued on next page)

Conclusions

1. Were you able to clean the dishes washed in cold water only? What would you change?

2. Were you able to see the differences in each set? Explain the differences for each dishpan of dishes.

3. What suggestions can you make for better dish washing at home? Share your list with the class. Share the list with your family so everyone will be following the same procedures.

Extra Ideas

- Bleach-water is great for kitchen clean-ups. Take heed when using bleach—it will take the color out of your clothes! Develop a list of cautionary suggestions for avoiding bleach splatters. Share this list with your family.
- Cross-contamination can be deadly. While it usually just makes you sick, it sure causes a lot of discomfort. Develop a system for marking cutting boards to avoid cross-contamination. Show some of your samples in class.
- Develop a list to reduce bacterium in your school kitchen and your home kitchen. Share your list with other students.
- Research cleaning products. Do commercially prepared cleaners work better than homemade cleaners? List your findings.
- Develop a different observation chart for your experiment. What would you include? Share your sample with classmates.
- How can you help minimize the likelihood of any food borne illness in your home kitchen? Participate in a discussion with your class regarding safe and sanitary procedures.
- Conduct a workshop for non-FACS students on "kitchen cleanliness" and its importance on good health.
- Practice making labels promoting the benefits of your "new soap product." The labels can be made on the computer or produced by hand (drawings, pastels, paints, collage, colored pencils, etc.). Remember to keep them creative, informative, and persuasive.
- Create a "Clean Kitchen" check-off sheet. Have those in your household check off responsibilities as they help keep the kitchen clean.
- Research vinegar as a cleaning agent. What were your on-line findings? What other information did you obtain? Share your findings in a class discussion.

Name ______________________________ Date ____________ Class ______________

Food Science

Experiment 12

Grain Retain—Water Retention When Cooked

Objective

- ◆ To determine how much moisture is contained in different types of grains after cooking.

Text Reference

- ◆ *Food for Today*, Unit 2, Ch. 9
- ◆ *Food for Today*, Unit 7, Ch. 32

■ Background Information ■

Nutritionists and other health experts advise that people get adequate supplies of the nutrient water every day. This can be a problem for certain segments of the population, especially aging adults, whose bodies' thirst signals often decline. As a result, they don't drink as much water as their bodies need.

One way for all people to be sure they get the necessary amount of water is through drinking beverages, all of which contain some water. Another approach is to eat foods with a high water content.

One such group of foods is natural grains, such as rice, which need to absorb considerable water before they become digestible to humans. In this experiment, you and several classmates will find out precisely how much water various grains soak up in the course of cooking. You will compare two different types of grain products, examining the changes in weight each undergoes after cooking.

■ Supplies ■

_____ 1 c. (250 mL) uncooked rice (not instant rice)

_____ 1 c. (250 mL) small dried pasta, such as elbow macaroni

_____ kitchen scale

_____ 1-qt. (1-L) measuring cup

_____ 2 medium saucepans

■ Procedure ■

_____ 1. You and a classmate are each to choose to work with either rice or a small dried pasta, such as elbow macaroni, for the experiment.

_____ 2. Place 1 cup (250 mL) of your grain on the kitchen scale. Record the type of grain you are working with and its dry weight in the appropriate columns of your Observation Chart.

_____ 3. Transfer the grain to a large saucepan. Add water, as called for in the recipe for this amount of the grain. (You may need to compute the amount of water for the amount of pasta being cooked.)

_____ 4. Cook the grain for the duration indicated on the package. Drain the grain in a strainer or colander. Allow it to cool before proceeding to the next step.

_____ 5. Return your cooked, drained grain to the kitchen scale. Record its weight in the column of your Observation Chart labeled "Cooked Weight."

(Continued on next page)

Observations

_____ 1. Compare the net weight of your grain before and after cooking. Express this value as a ratio (by dividing the greater number by the smaller).

_____ 2. Compare the amount of water your type of grain absorbed with the amount absorbed by the other type.

OBSERVATION CHART		
Type of Grain	**Dry Weight**	**Cooked Weight**

Conclusions

1. How much water did your grain absorb? How were you able to determine this?

____

____

____

2. Would someone who ate this grain after it has been cooked take in precisely the amount of water the grain absorbed? Why or why not?

____

____

____

3. Which type of grain would be the best choice for someone who doesn't consume adequate amounts of water each day?

____

____

____

Extra Ideas

- Repeat the experiment with brown rice. What difference do you observe?
- Repeat the experiment with a short grain rice such as Arborio or Asian sweet sticky rice. What difference do you observe?
- Investigate which foods have the highest ratio of water to dry weight. Share your findings with the class in a brief oral summary.
- Think of other foods that absorb water. Measure the amounts by following the same procedure you did for the rice or pasta. What other methods could you use to determine the amount of absorption?

Food Science

Experiment 13

Heat & Protein Coagulation

Objective

- To test the effect of cooking time on the coagulation of protein.
- Learn the word ramekin.

Text Reference

- *Food for Today*, Unit 6, Ch. 26

Look for These Terms

- *coagulation* (koh-ag-you-LAY-shun): A process in which a liquid changes into a-semi-solid or solid mass.
- *denaturation* (dee-nay-chur-AY-shun): A change in the shape of protein molecules, resulting in a change in the product.

Background Information

Coagulation is the process by which liquid protein changes into a semi-solid or solid. The process begins when protein molecules undergo *denaturation* or a change in their shape. The molecules unfold, collide with other protein molecules, and then clump together to form a solid. Adding heat is one way to coagulate protein.

In this experiment, you will prepare a simple baked custard. The custard is baked in four ramekins (custard cups) which are placed in a pan of hot water. The hot water protects the custard from the oven heat and makes it easier for you to control the coagulation process. You will not overcook the custard as easily.

At specific intervals, you will remove a custard sample from the oven. You will observe the effect of baking custards for different lengths of time.

Supplies

_____ 1 egg, well beaten
_____ ⅔ cup (150 mL) milk
_____ 5 tsp. (25 mL) sugar
_____ ¼ tsp. (1 mL) pure vanilla extract
_____ water
_____ 4 ramekins (custard cups)
_____ 9-in. (23-cm) square pan
_____ mixing bowl
_____ fork or wire whisk
_____ liquid measuring cup
_____ measuring spoons
_____ rubber spatula
_____ wooden spoon
_____ teakettle
_____ cooling rack
_____ 4 small paper plates
_____ 4 self-sticking labels
_____ pencil or marker
_____ 4 spoons

(Continued on next page)

Procedure

_____ 1. Heat water in teakettle but do not boil.

_____ 2. Preheat oven to 325°F (160°C).

_____ 3. Combine beaten egg, milk, sugar, and vanilla in bowl and mix well.

_____ 4. Divide mixture evenly into four ramekins.

_____ 5. Place ramekins in square baking pan. Be careful that cups do not touch each other or sides of the pan.

_____ 6. Using a potholder, pull the oven rack out just enough so you can set the pan on it. Pour water into pan up to ¾ of the custard in the cups. Be careful not to get water on custard.

_____ 7. Gently push the oven rack back into the oven.

_____ 8. Bake the custard at 325°F (160°C).

_____ 9. Mark the four adhesive labels as follows: "A—20 min."; "B—35 min."; "C—40 min."; and "D—60 min."

_____ 10. Place four small paper plates on a cooling rack.

_____ 11. Stick an adhesive label on the rim of each of the plates close to the edge.

_____ 12. Remove one ramekin from the oven at the end of the following baking times:

_____ 20 minutes _____ 40 minutes

_____ 35 minutes _____ 60 minutes

_____ 13. Place each ramekin on the proper paper plate on the cooling rack.

Observations

_____ 1. Observe the outside appearance of each sample. Record your observations in the appropriate blanks on the Observation Chart.

_____ 2. Spoon a little custard from each cup onto the plate on which the cup rests.

_____ 3. Examine the appearance and texture of the inside of the custard. Record your observations in the appropriate blanks on the Observation Chart.

_____ 4. Taste each of the samples that appears fully cooked, using a clean spoon for each. *Do not taste any sample that is still liquid or very runny.* Record your observations in the appropriate blanks on the Observation Chart.

Conclusions

1. Which custard has the best appearance? Explain.

____

____

2. Which custard has the best texture? Explain.

____

____

3. Which has the best flavor? Explain.

____

____

(Continued on next page)

OBSERVATION CHART				
Characteristics	**A** **20 minutes**	**B** **35 minutes**	**C** **40 minutes**	**D** **60 minutes**
Appearance: Outside				
Inside				
Texture				
Flavor				

4. Overall, which of the samples would you prefer?

____

____

5. Which of the samples would you prefer least? Why?

____

____

6. Were any of the samples inedible? If so, what made them inedible?

____

____

7. Of what practical use is the information you learned in this experiment?

____

____

■ Extra Ideas ■

◆ The thoroughly cooked custard may be eaten as a snack. Discard the others.
◆ Publish your results by recording a summary of this experiment and your conclusions in your Food Science Journal.
◆ Research the word *bain marie*. What were your findings?
◆ Research the word *crème brûlée*. What were your findings?
◆ Prepare custard on a cooktop rather than baking it in an oven. Compare the finished products. Did you have a favorite?

Name ______________________________ Date ____________ Class ______________

Food Science

Experiment 14

Fresh or Not? That Is the Juice Question!

Objective

- To use the senses of smell, taste, and touch in a blindfold rating of fruit juice.

Look for This Term

- *sensory characteristics* (SEN-sore-ee): Qualities of food identified by the five human senses of seeing, hearing, smelling, touching, and tasting.

Text Reference

- *Food for Today*, Unit 2, Ch. 5, 8
- *Food for Today*, Unit 3, Ch. 10
- *Food for Today*, Unit 7, Ch. 30

Background Information

Food science experiments often require observation of sensory characteristics—how food looks, tastes, smells, feels, and even sounds. These qualities are difficult to evaluate because they are based on human judgment, which is individual and not always consistent.

Sensory evaluation methods are used by taste-testing panels, which are one of many testing methods common in the food industry. Several people make up the panel of judges. They can be blindfolded or not, depending on the type of evaluation desired.

As a rule, people tend to score the first portion they sample higher than others. To avoid this problem, judges have a "pre-tasting" session in which they taste a sample but do not give it a score.

In this experiment, you will be judging four different kinds of orange juice: frozen, fresh, canned, and powdered. Each cup will have 3 Tbsp. (45 mL) juice. During the experiment, you will work with a classmate. One of you will be the Judge, who taste-tests the fruit juice. The other will be the Assistant.

The Judge will be blindfolded, so the fruit juices will be evaluated by taste, aroma, and touch—the "feel" of the juice in the mouth. When taste-testing, do not drink all the juice in the cup. Just sip a small mouthful and swish it around in your mouth so you get the full flavor and "feel" of the juice before swallowing it. Smell the aroma of the juice in the cup. You will score the juice on the rating scale described on the Score Chart.

Rely on your first impressions, but if you cannot make up your mind, take another sip. Once you have completed testing one sample and have started another one, you will not be allowed to re-taste a previous one.

The Assistant serves the juice to the Judge and should be careful to place the cup firmly in the Judge's hand. Remember, the Judge is blindfolded and cannot see where the cup is. When the Judge has given a score, the Assistant will mark it on the Judge's Score Chart. The Assistant should be careful to mark the score in the proper blank. The Assistant will then remove the cup from the Judge's hand and place it on another tray. Between each sample, the Assistant should hand the Judge a glass of water to clear the taste buds. After the Judge has sipped water, the Assistant will hand the Judge the next cup.

The taste test will be repeated three times, with the order of the samples changed each time. Repeating the taste test makes it easier to reach consistent, valid conclusions. The Assistant should keep a list of the order in which the samples are served to make sure that all three taste tests are conducted in a different order.

Samples of juice should be the same temperature—chilled but no ice. They should all be served in the same kind of drinking container.

(Continued on next page)

Supplies

- ______ blindfold
- ______ 13 3-oz. paper cups
- ______ 2 trays
- ______ markers
- ______ pen
- ______ ¾ cup (175 mL) frozen orange juice, reconstituted
- ______ ¾ cup (175 mL) fresh orange juice
- ______ ¾ cup (175 mL) canned orange juice
- ______ ¾ cup (175 mL) powdered orange juice, mixed according to package directions
- ______ glass of water
- ______ pencil or nontoxic waterproof marker
- ______ 4 adhesive labels
- ______ paper towels

Procedure

______ 1. Mark the four adhesive labels as follows: "A—Fresh"; "B—Frozen"; "C—Canned"; and "D—Powdered." Attach each label to the side of the appropriate juice container.

______ 2. Use the pen to mark the sides of each set of 3 paper cups as follows: "A—Fresh"; "B—Frozen"; "C—Canned"; "D—Powdered." You should have four groups of cups, three with the same adhesive label in each group.

______ 3. Arrange the juice containers and cups on a tray in groups, beginning with "A" and ending with "D."

______ 4. Mark the remaining cup "X" and place it on the tray. That cup will be used for the prejudging sample.

______ 5. Fill each cup half full with the juice from the container labeled the same as the cup. Use any juice for cup "X."

______ 6. Place a glass of water on the tray and an empty tray next to the one holding the samples.

______ 7. The Judge should sit across the table from the Assistant.

______ 8. The Assistant should have the Judge's Score Chart, a pen, and a supply of paper towels to wipe up spills.

______ 9. The Assistant should also have a sheet of paper to keep track of the order in which the beverages are served. Each time the experiment is repeated, the order of the beverages should be changed.

______ 10. Blindfold the Judge.

Observations

______ 1. Give cup "X" to the Judge. Then give the Judge the glass of water.

______ 2. Trial 1: Assistant places a sample in the Judge's hand.

______ 3. Judge smells and tastes the juice and gives it a rating from 1 (poor) to 4 (excellent).

______ 4. Assistant writes down Judge's rating in proper blank on Score Chart.

______ 5. Assistant removes the cup from Judge's hand and places it on empty tray.

______ 6. Assistant places glass of water in Judge's hand and removes it when Judge has taken a sip.

______ 7. Assistant places second cup in Judge's hand, noting on list the order in which the juices are tasted.

______ 8. Judge smells and tastes the juice from the second cup and gives it a rating from 1 (poor) to 4 (excellent).

______ 9. Assistant writes down Judge's rating in proper blank on Score Chart and removes cup from Judge's hand.

(Continued on next page)

_____ 10. The process is repeated with the two remaining samples, completing Trial 1. Assistant should remember to give Judge a sip of water after each sample.

_____ 11. For Trial 2, the process is repeated. However, the order in which the juices are served is changed by the Assistant.

_____ 12. The process is repeated once more for Trial 3, with the order in which the juices are served changed again.

_____ 13. When the three trials are completed, there should be a number in each blank on the Score Chart.

SCORE CHART				
Judge's Name	**A Fresh**	**B Frozen**	**C Canned**	**D Powdered**
Trial 1				
Trial 2				
Trial 3				
Totals				

Rating Scale: 4 = Excellent: "I love it."
3 = Good: "I like it."
2 = Fair: "It's OK but I wouldn't buy it."
1 = Poor: "I don't like it."

Conclusions

1. Add the numbers in each column. Which juice was the "favorite" (i.e., had the highest number)?

2. Which juice was the least "favorite" (i.e., had the lowest score)?

(Continued on next page)

3. How did the results of the test compare with the way you normally feel about the four products tested?

4. Were you surprised by the results? Why?

5. How do you think using the blindfold affected the outcome of the test?

Extra Ideas

- Any remaining juice can be used for a snack.
- Use the remaining juice to make a fruit smoothie.
- Use the remaining juice to flavor frosting for a cake.
- Redo the experiment using grapefruit juice or another juice of choice.
- Develop another experiment conducting taste tests.

Name ______________________ Date ____________ Class ______________

Food Science

Experiment 15

Smell/Taste Connection

Objective

◆ To observe the role of the sense of smell in the experience of tasting food.

Text Reference

◆ *Food for Today*, Unit 6, Ch. 28

Look for This Term

◆ *olfactory nerves*: A pair of nerves that connect smell receptors in the nasal cavity with sensors in the brain.

■ Background Information ■

You have probably experienced during a bout of allergies or a head cold that food tasted unusual or had no taste at all. The explanation for this phenomenon is that the sense of taste is largely dependent on the sense of smell. Some scientists estimate that smell accounts for up to 70 percent of what we perceive as taste.

Smell is actually a chemical message received by the nose, which is equipped with olfactory nerves, a pair of nerves that connect smell receptors in the nasal cavity with sensors in the brain. The olfactory nerves are responsible for differentiating among the various tastes of foods taken into the mouth.

Scientific research suggests that there are seven primary odors: camphor (similar to mothballs), musk, flower, peppermint, ethereal (dry-cleaning fluid, for example), pungent (vinegar), and putrid (foul-smelling). Every smell corresponds to one of the seven types of smell receptors in the olfactory cell hairs. Because of the relationship between taste and smell, isolating the taste of a particular food in the absence of smell can be challenging.

In this experiment, you will feed amounts of common foods to two groups of volunteers. Both groups will be blindfolded. One group will additionally pinch their nostrils shut during the tasting. You will observe the ability of subjects to taste without the use of the sense of smell and draw conclusions.

■ Supplies ■

_____ blindfolds, one for each subject

_____ plastic spoons

_____ small amounts of the following foods: slightly softened unsalted margarine, mayonnaise, plain yogurt, vanilla pudding, applesauce, bottled Italian or vinaigrette salad dressing, smooth (not chunky) peanut butter

_____ cups of water

■ Procedure ■

_____ 1. Find six volunteers to take part in a food-tasting experiment. Three volunteers are to be subjects in Group A; the other three, in Group B.

_____ 2. Ask Group B subjects to leave the room while you work with Group A so that they will not be influenced by the response of Group A subjects.

_____ 3. Each member of Group A is to wear a blindfold. Explain that you will feed each member a spoonful of a food. Note that all foods will be fairly similar in texture. Caution members not to say anything and not to react in any way until they are instructed to do so.

_____ 4. Feed each member a small sample of slightly softened unsalted margarine. Encourage each member to work the sample around between the tongue and hard palate to distribute the natural essences of the food throughout the oral cavity. Members are then to swallow.

(Continued on next page)

_____ 5. Ask members who recognized the food to raise their right hands. Have them quietly whisper the food's name in your ear. Have members place their hands back at their sides. Record correct and incorrect responses in the Observation Chart.

_____ 6. Ask members to raise their left hands if the food tasted sweet, their right hands if it tasted tart, or neither hand if the food was neither sweet nor tart. Again, record their observations.

_____ 7. Allow each group member to drink a cup of water, swishing the liquid around until his or her mouth is as free as possible of food residues.

_____ 8. Proceed in the same fashion for each of the remaining food samples.

_____ 9. Once all the foods have been sampled, repeat steps 3 through 8 with Group B. This time, subjects are to pinch their nostrils closed in addition to wearing blindfolds.

■ Observations ■

_____ 1. Compute the percentage of subjects from Group A who correctly identified a given sample. Compute a mean (average) percentage of correct answers for all foods sampled.

_____ 2. Make the same calculations for Group B results.

OBSERVATION CHART

	Group A		Group B	
Food	**Recognized (Y/N)**	**Sweet/Tart/Neither (S/T/N)**	**Recognized (Y/N)**	**Sweet/Tart/Neither (S/T/N)**
Margarine				
Mayonnaise				
Yogurt				
Pudding				
Applesauce				
Salad dressing				
Peanut butter				

(Continued on next page)

Conclusions

1. Compare the percentages from Groups A and B in your graph. What percentage of taste seems actually to be accounted for by smell? Explain.

2. Which foods, if any, did subjects from Group B find sweet? Tart? Neither sweet nor tart? What do these findings suggest about the connection between the foods sampled and the seven primary odors identified by scientists?

3. What role, if any, do you think texture may have played in the experiment?

Extra Ideas

- Try the experiment with six other foods, each with a texture different from those used in this survey.
- Convert the findings in your Observation Chart into a bar graph or other type of graph. Display your finished graph in the classroom.
- Try the experiment with different ethnic foods. Incorporate the Global Foods section of the text (Chapters 48-55).
- Add herbs or spices to your original foods on chart:
  – parsley or oregano added to margarine
  – mustard powder to mayonnaise
  – mint to yogurt
  – cardamom to pudding
  – cinnamon to applesauce
  – basil to salad dressing
  – powdered ginger to peanut butter
  Do these flavor changes make a difference in the experiment? What are your findings?
- Research "Sense of Smell" on those that have experienced a head injury. Does it differ from someone that has not experienced a head injury?

Name ______________________________ Date ____________ Class ______________

Food Science

Experiment 16

Emulsification—A Saucy Mix-Up

Objective

◆ To observe the impact of rates of incorporation of liquids in forming an emulsion.

Text Reference

◆ *Food for Today*, Unit 7, Ch. 35
◆ *Food for Today*, Unit 8, Ch. 41

Look for These Terms

◆ *emulsifier* (ih-MUL-suh-fye-uhr): A substance that coats the drops of one liquid so that it can remain mixed in another.
◆ *viscosity* (vis-KAHS-uh-tee): A substance's resistance to flow.

Background Information

There is truth in the saying that oil and water don't mix. You can shake the two liquids together to combine them temporarily. As soon as you stop shaking, however, the tiny oil droplets produced by the agitation begin to combine with one another. Soon the oil and water are separate again.

The egg yolks in mayonnaise contain a natural substance that acts as an *emulsifier,* a substance that coats the drops of one liquid so that it can remain mixed in another. Molecules of the yolk coat the oil droplets and cause them to-repel one another. The *viscosity* in the egg yolks impedes the flow of the vinegar (which is-mostly water), interfering with its ability to repel the oil. Therefore, the oil stays in small droplets that remain evenly mixed throughout the dressing. Mayonnaise is the most identified emulsified sauce.

In this experiment, you will test the ability of another substance, mustard, to enter into an emulsion. You will also determine whether speed (rate of incorporating liquids) is a factor in forming an emulsion.

Supplies

_____ measuring cup
_____ vinegar
_____ mixing bowl
_____ measuring spoons
_____ grain or dijon mustard
_____ salad oil
_____ handheld electric mixer
_____ 2 glass jars
_____ adhesive labels

Procedure

_____ 1. Measure out 3 tablespoons (45 mL) of vinegar, and transfer it to a mixing bowl. Measure out 3 tablespoons (45 mL) of mustard. Add the mustard to the vinegar. Measure out 1 cup (250 mL) of salad oil. Set aside.

_____ 2. On medium speed, beat the vinegar and mustard mixture with an electric mixer. As you do, add in a few drops of the salad oil. Once the mixture becomes thick, begin adding the remainder of the oil in a thin, steady stream. Pause every few moments to allow the additions to incorporate.

_____ 3. Transfer the mixture to a glass jar. Using an adhesive label, place "Sample A," on the jar.

_____ 4. Repeat step 1. This time, however, combine the vinegar, mustard, and salad dressing in the mixing bowl all at once. Beat at medium speed for 2 minutes.

_____ 5. Transfer the mixture to a second glass jar. Label the jar "Sample B."

(Continued on next page)

Observations

_____ 1. Inspect the two samples and evaluate them in terms of color and appearance. Document findings in the Observation Chart.

_____ 2. Taste the two samples. Describe their flavor and texture. Document findings in the Observation Chart.

OBSERVATION CHART				
	Color	**Appearance**	**Flavor**	**Texture**
Sample A				
Sample B				

Conclusions

1. Was the mustard an effective emulsifier?

2. What difference resulted from drizzling the oil in a little at a time versus adding it all at once? What conclusion about the process of emulsification can you draw from this?

3. Which of the two samples had a more pleasing color and appearance? Which had a better flavor?

4. Which of the two samples would you be more likely to use on a salad?

Extra Ideas

- Try making the mixture using the first process, this time using orange juice instead of vinegar. Describe the taste of the mixture. What other variations could you recommend?
- Read or review Unit 5 and Unit 8. What food safety problem associated with mayonnaise do you avoid when making the emulsion in this experiment?
- Develop a recipe using the emulsification techniques in the experiment.
- Experiment with blenders and food processors when making an emulsified sauce. Do you find a difference in texture?
- Genuine vinaigrettes are emulsions. Try mixing oil and vinegar with a fork, using only a few strokes. Does this compare to an actual emulsion?

Name ______________________ Date ____________ Class ____________

Food Science

Experiment 17

Smooth Sauces—Hold the Lumps

Objective

◆ To determine which preparation method is best for producing a smooth sauce when flour is used as a thickener.

Text Reference

◆ *Food for Today*, Unit 8, Ch. 43

Look for This Term

◆ *gelatinization* (jih-LAT-in-uh-ZAY-shun): The process that occurs when starch granules absorb liquid and swell.

■ Background Information ■

When starch granules such as flour are mixed with liquid and heated, they undergo *gelatinization.* The granules absorb liquid and swell. As heating continues, the starch mixture thickens into a paste. This thickening process is the basis for many sauces.

One of the most important steps in this process is the mixing of starch and liquid before heating begins. In this experiment, you will prepare a simple sauce using three different mixing methods. You will then compare the samples to determine how the mixing method affected the finished products.

When making your observations, observe the texture of the sauce by spooning a small amount on a colored plate. The colored background will make it easier to see variations in thickness. Test texture by rubbing some of the sauce between your fingers. You can also observe texture by tasting the sauce and determining how it "feels" in your mouth.

■ Supplies ■

_____ 3 cups (750 mL) cold tap water (divided)
_____ 9 Tbsp. (135 mL) all-purpose flour (divided)
_____ 3 Tbsp. (45 mL) butter or margarine (divided)
_____ 3 chicken bouillon cubes
_____ teakettle or saucepan
_____ small saucepan
_____ 1-cup (250-mL) liquid measure
_____ measuring spoons
_____ rubber spatula
_____ fork or wire whisk
_____ 3 small bowls
_____ mixing spoon
_____ 6 small adhesive labels
_____ pencil or nontoxic waterproof marker
_____ 6 spoons
_____ 3 small colored paper plates
_____ timer

(Continued on next page)

■ Procedure ■

_____ 1. Heat 1 cup (250 mL) cold tap water in a teakettle or saucepan.

_____ 2. Mark two adhesive labels "A—Flour + Cold Water." Mark another two labels "B—Flour + Hot Water" and the remaining two, "C—Melted Butter + Flour."

_____ 3. Arrange 3 small bowls in a row. Place a small colored paper plate in front of each bowl.

_____ 4. Stick one adhesive label "A" on the side of the first bowl and one on the rim of the paper plate in front of the bowl.

_____ 5. Label the second bowl and paper plate with the labels marked "B."

_____ 6. Label the third bowl and paper plate with the labels "C."

_____ 7. Measure 1 cup (250 mL) cold water and pour into a small saucepan.

_____ 8. Measure 3 Tbsp. (45 mL) all-purpose flour and add to the water in the saucepan.

_____ 9. Use a fork or wire whisk to completely mix the flour and the cold water.

_____ 10. Add 1 Tbsp. (15 mL) butter or margarine and 1 chicken bouillon cube to the mixture.

_____ 11. Heat the mixture on low heat, stirring gently with whisk or mixing spoon until bubbly.

_____ 12. Allow to bubble for one minute while stirring constantly.

_____ 13. Remove from the heat and pour the sauce into the small bowl labeled "A—Flour + Cold Water."

_____ 14. Recall how easily and quickly the sauce mixed, from the time you combined the first two ingredients to the finished product. Record your observations in the proper blank on the Observation Chart.

_____ 15. Wash all equipment carefully.

_____ 16. Measure 1 cup (250 mL) very hot water from the teakettle and pour into the clean saucepan.

_____ 17. Measure 3 Tbsp. (45 mL) all-purpose flour and add to the hot water in the saucepan.

_____ 18. Use a fork or wire whisk to completely mix the flour and the hot water.

_____ 19. Add 1 Tbsp. (15 mL) butter or margarine and 1 chicken bouillon cube to the mixture.

_____ 20. Heat the mixture on low heat, stirring gently with a whisk or spoon until bubbly.

_____ 21. Allow to bubble for one minute while stirring constantly.

_____ 22. Remove from the heat and pour the sauce into the small bowl labeled "B—Flour + Hot Water."

_____ 23. Recall how easily and quickly the sauce mixed. Record your observations in the proper blank on the Observation Chart.

_____ 24. Wash all equipment using careful sanitation procedures.

_____ 25. Measure 1 Tbsp. (15 mL) butter or margarine and place into the clean saucepan.

_____ 26. Melt butter or margarine, using low heat.

_____ 27. Add 3 Tbsp. (45 mL) all-purpose flour to the melted butter. Mix thoroughly, using a mixing spoon or wire whisk.

_____ 28. Add 1 cup (250 mL) cold tap water and 1 bouillon cube to the butter-flour mixture.

_____ 29. Heat slowly over low heat, stirring with a mixing spoon or wire whisk, until mixture bubbles.

_____ 30. Continue to stir and cook for 1 minute.

(Continued on next page)

______ 31. Remove from heat.

______ 32. Pour sauce into the small bowl labeled "C—Melted Butter + Flour."

______ 33. Recall how easily and quickly the sauce mixed. Record your observations in the proper blanks on the Observation Chart.

Observations

______ 1. Spoon a little sauce from bowl "A" onto the paper plate marked "A." Place the spoon on the paper plate beside the sample.

______ 2. Examine the texture, feeling it with your fingers if necessary. Put a small amount on your tongue to "feel" the texture in your mouth. Record your observations in the appropriate blank in column "A" on the Observation Chart.

______ 3. Using a clean spoon, transfer a little sauce from bowl "B" onto the paper plate marked "B." Place the spoon on the paper plate beside the sample.

______ 4. Examine the texture as you did with sample A. Record your observations in the appropriate column "B" on the Observation Chart.

______ 5. Using a clean spoon, transfer a little sauce from bowl "C" onto the paper plate marked "C." Place the spoon on the paper plate beside the sample.

______ 6. Examine the texture as you did with the two previous samples. Record your observations in the appropriate blank in column "C" on the Observation Chart.

______ 7. Using a clean spoon, taste a small amount of sauce from bowl "A." Record your observations in the appropriate blank in column "A" on the Observation Chart.

______ 8. Using a clean spoon, taste a small amount of sauce from bowl "B." Record your observations in the proper blank in column "B" on the Observation Chart.

______ 9. Using a clean spoon, taste a small amount of sauce from bowl "C." Record your observations in column "C" on the Observation Chart.

OBSERVATION CHART			
Characteristics	**A Flour + Cold Water**	**B Flour + Hot Water**	**C Melted Butter + Flour**
Ease of mixing			
Texture			
Flavor			

(Continued on next page)

■ Conclusions ■

1. Which sauce mixed most easily? Why?

2. Which sauce was most difficult to mix? Why?

3. Which sauce did you prefer for texture? Why?

4. What differences did you note in the flavor of the three sauces?

5. If you were handed a list of ingredients for preparing a similar sauce but no mixing directions, which method would you use? Why?

■ Extra Ideas ■

- Discard the paper plates. Use the sauces left in the bowls to prepare creamed vegetables, cream soup, or a casserole.
- If any sauce is lumpy, put it through a fine-mesh strainer before using it.
- Publish your results by recording a summary of this experiment and your conclusions in your Food Science Journal.
- Develop three original recipes; a creamed vegetable, a cream soup, and a casserole with a cream base.
- Research the word *chinois*. Write a description of its use and make an illustration to accompany your description.

Name ______________________________ Date ______________ Class ________________

Food Science

Experiment 18

Kneading It—Effects on Quick Breads

Objective
◆ To determine the effect of gluten, developed by stirring muffin batter, on the finished muffins.

Look for This Term
◆ *gluten* (GLOO-ten): The protein complex formed when wheat flour is mixed with liquid.

Text Reference
◆ *Food for Today*, Unit 9, Ch. 44, 45

■ Background Information ■

Gluten is made up of the proteins in flour. As batter is mixed, the gluten develops into an elastic mesh. Air or gas becomes trapped in the gluten, forming tiny cells that expand as the product is heated. The more gluten is mixed, the stronger it becomes. The stronger it is, the more easily it expands.

In this experiment, you will make a muffin recipe which yields six muffins. The batter will be mixed three different ways, giving you an opportunity to compare the effects of mixing methods on the finished muffins.

■ Supplies ■

_____ 1 cup (250 mL) all-purpose flour
_____ 1½ tsp. (8 mL) double-acting baking powder
_____ ¼ tsp. (1 mL) salt
_____ 1 Tbsp. (15 mL) granulated sugar
_____ 2 Tbsp. (30 mL) vegetable oil
_____ ½ cup (125 mL) milk
_____ 1 egg
_____ 6 paper muffin cup liners (2 each of 3 colors)
_____ muffin pan with 6 cups
_____ measuring spoons
_____ dry measuring cups
_____ liquid measuring cup
_____ sifter
_____ rubber spatula
_____ medium mixing bowl
_____ small mixing bowl
_____ fork
_____ mixing spoon
_____ cooling rack
_____ knife
_____ cutting board
_____ ruler

■ Procedure ■

_____ 1. Preheat oven to 400°F (200°C).
_____ 2. Place muffin cup liners in pan so that two of the same color are next to each other.
_____ 3. Measure flour, baking powder, salt, and sugar into a sifter.
_____ 4. Sift dry ingredients together into medium mixing bowl.
_____ 5. Break egg into small mixing bowl and beat lightly with a fork.

(Continued on next page)

______ 6. Add vegetable oil and milk to beaten egg. Mix with a fork.

______ 7. Add mixed liquid ingredients to dry ingredients in medium mixing bowl.

______ 8. Stir batter 12 strokes with a wooden spoon. Count strokes carefully. Batter will be barely moistened.

______ 9. Spoon out enough batter into the muffin pan to fill two paper liners of the *same color* two-thirds full. On the Observation Chart, write the color of the paper liners you just filled in the appropriate blank under "A—Stirred 12 Strokes."

______ 10. Stir the remaining batter 6 more strokes.

______ 11. Spoon out enough batter to fill two muffin liners of a second color two-thirds full. On the Observation Chart, write the color of the liners you just filled in the appropriate blank under "B—Stirred 18 Strokes."

______ 12. Stir the remaining batter 12 more strokes.

______ 13. Fill the remaining two muffin liners of the same color two-thirds full. On the Observation Chart, write the color of the liners you just filled in the appropriate blank under "C—Stirred 30 Strokes."

______ 14. Place the muffin pan in the preheated oven at 400°F (200°C) and bake for 15-18 minutes or until golden brown.

______ 15. Remove the muffin pan from the oven.

______ 16. Gently remove the muffins from the pan and place on a cooling rack. Keep the muffins in matching colored liners together, so you have three pairs of muffins.

______ 17. Remove the paper liner from one muffin of each pair. Set each muffin on its removed liner so you can identify it.

______ 18. Using a sharp knife and a cutting board, carefully cut one of the muffins without the liner in half from top to bottom.

______ 19. Place the two halves on the correct liner next to the whole muffins with the same color liner.

______ 20. Repeat the process by cutting one muffin from each of the remaining pairs in half. Place the cut halves on the correct color liner, next to the matching whole muffin.

■ Observations ■

______ 1. Observe the shape of each sample. Record your observations in the proper blanks on the Observation Chart.

______ 2. Observe the crust of each sample. Notice characteristics such as color and smoothness. Record your observations in the proper columns on the Observation Chart.

______ 3. Measure the height of each sample with a ruler. Do this by measuring one of the cut halves. Record the height of each sample in both inches and centimeters on the Observation Chart.

______ 4. Examine a cut half of each sample and note the texture and color. Do you see any tunnels or holes? Record your observations on the Observation Chart.

______ 5. Break off a small piece of one of the halves and chew it. Judge it for texture and tenderness. Record your observations on the Observation Chart.

(Continued on next page)

OBSERVATION CHART			
Characteristics	**A Stirred 12 Strokes**	**B Stirred 18 Strokes**	**C Stirred 30 Strokes**
Color of paper liner			
Outside: Shape			
Crust			
Height	**in.** **cm**	**in.** **cm**	**in.** **cm**
Inside: Texture			
Color			
Tenderness			

■ Conclusions ■

1. What was the effect of increased stirring on the development of gluten in the batter?

____

____

2. How did the increase in the number of times the batter was stirred affect the quality of the muffins? Explain.

____

____

____

____

(Continued on next page)

3. Which muffin sample was the best example of a quality product? What is the reason for the difference?

4. What conclusions can you draw from this experiment?

5. Of what practical value is this information?

Extra Ideas

- Serve the muffins as a snack or with a meal.
- Publish your results by recording a summary of this experiment and your conclusions in your Food Science Journal.
- Isolate the gluten from all-purpose flour, cake flour, and bread flour. Mix 1 cup of flour with 5-8 tablespoons of water (just enough to form a stiff dough.) Knead until elastic. Let the dough rest about 15 minutes. Place the dough in a bowl of cool water. Knead the dough under the water, changing the water until it becomes clear. You have washed away the starch. Repeat process with remaining two types of flour. Is there a difference between the flour frameworks? Bake each of the gluten balls in a 350°F oven until they feel firm. Compare the three after baking. What were the results?

Name ______________________ Date __________ Class __________

Food Science

Experiment 19

Kneading It Too—Effects on Yeast Breads

Objective

◆ To determine the effect of kneading on the development of gluten in yeast dough.

Text Reference

◆ *Food for Today*, Unit 9, Ch. 44, 45

Look for This Term

◆ *gluten* (GLOO-ten): The protein complex formed when wheat flour is mixed with liquid; gives shape and structure to baked-goods.

■ Background Information ■

Gluten is made up of the proteins in flour. As dough is kneaded, gluten develops, and the dough becomes smooth and elastic. Because it is elastic, the dough can expand easily, giving bread a coarser texture than baked products that are not kneaded, such as cakes.

In this experiment, you will make two loaves of bread, kneading each one for a different amount of time. The dough will be prepared one day and baked the next.

■ Supplies ■

_____ 1 tsp. (5 mL) shortening
_____ 1 tsp. (5 mL) active dry yeast
_____ 1⅛ cup (275 mL) warm water—110°F (43°C)
_____ ½ Tbsp. (8 mL) shortening
_____ 1 Tbsp. (15 mL) sugar
_____ 1 tsp. (5 mL) salt
_____ 2⅞ to 3⅛ cups (700-775 mL) all-purpose flour, divided
_____ large mixing bowl
_____ measuring spoons
_____ mixing spoon
_____ sharp knife
_____ dry measuring cup
_____ 2 small loaf pans, 3" × 6¾" × 2" (7.5 × 17 × 5 cm)
_____ strip of baking parchment or aluminum foil, 1" × 6" (2.5 cm × 15 cm)
_____ plastic wrap
_____ 2 cooling racks
_____ rubber spatula
_____ 2 adhesive labels
_____ pencil or marker
_____ ruler

■ Procedure ■

_____ 1. Use 1 tsp. (5 mL) shortening to grease the two loaf pans. Place the parchment or foil strip in one pan so that it extends over the edge of the pan.

_____ 2. Soften yeast in the warm water in a large mixing bowl.

_____ 3. Add ½ Tbsp. (8 mL) shortening and 1 Tbsp. (15 mL) sugar.

_____ 4. Stir to dissolve.

_____ 5. Add salt and 1½ cups (375 mL) flour.

(Continued on next page)

_____ 6. Mix.

_____ 7. Continue adding flour until the mixture forms a soft dough. (Amount of flour needed may vary.)

_____ 8. Turn out on a lightly floured surface and knead for 15 seconds.

_____ 9. Divide dough in half.

_____ 10. Place half of dough in the greased loaf pan with the parchment or foil strip. This will identify it as "A—15 sec."

_____ 11. Knead remaining dough for 8-10 minutes or until smooth and elastic.

_____ 12. Place dough in second greased pan. This loaf will be "B—10 min."

_____ 13. Let both loaves rise until double, approximately 1 to 1½ hours.

_____ 14. After rising is completed, cover both loaf pans with a greased piece of plastic wrap.

_____ 15. Refrigerate.

_____ 16. The following day, preheat oven to 350°F (180°C).

_____ 17. Bake both loaves for 20 minutes at 350°F (180°C).

_____ 18. Mark two adhesive labels as follows: "A—15 sec." and "B—10 min."

_____ 19. Attach one adhesive label to each cooling rack, near the edge.

_____ 20. When bread is done, remove the pans from the oven.

_____ 21. Remove the loaf from the pan with the parchment or foil strip and place on cooling rack labeled "A—15 sec."

_____ 22. Remove the loaf from the other pan and place on cooling rack labeled "B—10 min."

_____ 23. Let loaves cool.

■ Observations ■

_____ 1. Cut loaves in half.

_____ 2. With a ruler, measure the height of each loaf where it was cut. Record the height in both inches and centimeters in the proper blanks on the Observation Chart.

_____ 3. Observe the appearance of each loaf, both outside and inside. Record your observations in the proper blanks on the Observation Chart.

_____ 4. Cut a slice from each loaf. Keep each slice on the cooling rack so you do not mix them up.

_____ 5. Tear each slice apart and note the texture of the crust and interior. Record your observations in the proper blanks on the Observation Chart.

_____ 6. Put a small portion of the crust from sample "A" in your mouth and chew it. Note the texture. Record your observations in the proper blank on the Observation Chart. Do the same with sample "B."

_____ 7. Put a small portion of the bread without crust from sample "A" in your mouth and chew it. Note the texture. Record your observations in the proper blank on the Observation Chart. Do the same with sample "B."

_____ 8. Taste a small portion of sample "A" for flavor. Record your observations in the proper blank on the Observation Chart. Do the same with sample "B."

(Continued on next page)

OBSERVATION CHART		
Characteristics	**A 15 seconds (with Parchment/Foil)**	**B 10 minutes**
Height	**in.** **cm**	**in.** **cm**
Appearance: Outside		
Inside		
Texture: Crust		
Inside		
Flavor		

Conclusions

1. Which crust has the preferable appearance?

____

____

____

2. Describe the differences in the two loaves, both inside and outside.

____

____

____

3. Which loaf was easier to chew? What do you think is the reason for the difference?

____

____

____

____

(Continued on next page)

4. Which loaf had a better flavor?

5. Of what practical use is the information you gained in this experiment?

■ Extra Ideas ■

- Store the bread and use whenever needed, or serve with a spread as a class snack.
- Make bread crumbs: slice bread and let dry at room temperature. Use blender to make crumbs. Store in a tightly covered container and use as needed.
- Publish your results by recording a summary of this experiment and your conclusions in your Food Science Journal.
- Research kneading techniques. Practice kneading.
- Develop a bread recipe that uses the techniques described in the experiment and in Unit 9 of the *Food for Today* text.

Name ______________________ Date ____________ Class ____________

Food Science

Experiment 20

Substituting the Sugar—Does It Work?

Objective

- ◆ To observe the effect of substituting artificial sweeteners for the granulated sugar in a shortened cake.

Text Reference

- ◆ *Food for Today*, Unit 1, Ch. 3
- ◆ *Food for Today*, Unit 5, Ch. 20
- ◆ *Food for Today*, Unit 9, Ch. 46

Look for These Terms

- ◆ *saccharin* (SACK-uh-rihn): An artificial sweetener banned at one time by the FDA (Food and Drug Administration) but brought back by consumer demand.
- ◆ *aspartame* (as-PAHR-tame): An artificial sweetener that adds very few calories to foods.
- ◆ *sucralose* (see Extra Ideas)

■ Background Information ■

In an effort to reduce the sugar and calories in baked products, people often attempt to substitute artificial sweeteners for some or all of the sugar in a recipe. This method of reducing calories works better in some cases than in others. Even sugar substitutes recommended for baking result in products of varying quality.

In this experiment, you and your classmates will test the effect of substituting two artificial sweeteners for part of the granulated sugar in a basic shortened cake. One of the artificial sweeteners contains saccharin, and the other contains aspartame. These are the two most common types of artificial sweeteners, and both are actually sweeter than sucrose (granulated sugar).

■ Supplies ■

_____ liquid measuring cup

_____ dry measuring cup

_____ round 9-inch (23-cm) cake pan

_____ electric mixer

_____ mixing bowl

_____ rubber spatula

_____ serving plate

_____ knife to cut cake

_____ 3 adhesive labels per group member, plus 1 extra label

_____ nontoxic marking pen

_____ small paper plates for tasting

_____ fork

_____ 1 cup (250 mL) all-purpose flour

ONE of the following as directed by your teacher:

_____ ¾ cup (175 mL) granulated sugar

_____ 2 tsp. (10 mL) artificial sweetener containing saccharin AND ¼ cup (50 mL) granulated sugar

_____ ½ cup (125 mL) artificial sweetener containing aspartame AND ¼ cup (50 mL) granulated sugar

_____ 2 tsp. (10 mL) baking powder

_____ ½ tsp. (3 mL) salt

_____ ¼ cup (50 mL) shortening

_____ ½ cup (125 mL) milk

_____ ½ tsp. (3 mL) vanilla

_____ 2 large eggs

_____ a small amount of extra flour and shortening to grease and flour baking pan

(Continued on next page)

■ Procedure ■

_____ 1. Record the type of sweetener your teacher assigned you by circling it in the Observation Chart.

_____ 2. Write "A—Sugar," "B—Saccharin," and "C—Aspartame" on three of the four labels. Attach the labels to a paper plate as far apart as possible.

_____ 3. Write the variation your teacher assigned to you on the fourth label and place it on the edge of the serving plate.

_____ 4. Preheat oven to 350°F (180°C).

_____ 5. Grease and flour cake pan.

_____ 6. Put flour, sugar and/or artificial sweetener, baking powder, salt, shortening, milk, and vanilla in mixing bowl.

_____ 7. Beat on low speed, scraping bowl constantly, until dry ingredients are absorbed, about 30 seconds.

_____ 8. Beat on high speed for 2 minutes, scraping bowl as necessary.

_____ 9. Add eggs.

_____ 10. Beat on high speed for 2 minutes more.

_____ 11. Pour or scrape batter into pan.

_____ 12. Bake until wooden pick or cake tester inserted in center comes out clean (about 25 minutes).

_____ 13. Remove cake from oven and cool on a wire cooling rack 10 minutes; then remove cake from pan and place on cooling rack until completely cool.

_____ 14. Cut cake into enough small pieces so that everyone in your class can have one to taste-test. Place pieces on serving plate and take to the taste-testing area.

_____ 15. From the serving plates in the taste-testing area, take one sample of each variation. Be sure to place each sample on your paper plate by the appropriate label.

■ Observations ■

_____ 1. Examine the three samples and notice any differences in appearance. Record your observations in the proper blanks on the Observation Chart.

_____ 2. Smell the samples and note differences in aroma, if any, in the three samples. Record your observations in the proper blanks on the Observation Chart.

_____ 3. With a fork, cut each sample and note any differences in texture. Record your observations in the proper blanks on the Observation Chart.

_____ 4. Taste each sample. Note any differences in texture and flavor. Record your observations in the proper blanks on the Observation Chart.

(Continued on next page)

OBSERVATION CHART			
Characteristics	**Sample A Sugar**	**Sample B Saccharin**	**Sample C Aspartame**
Appearance			
Aroma			
Texture			
Flavor			

Conclusions

1. What differences did you notice in the texture and flavor of the cakes made with the three types of sweeteners? How can you explain these differences?

2. Why are artificial sweeteners that contain aspartame not recommended for use in baked goods?

3. Aside from calories, what other factors would you take into consideration before using an artificial sweetener in a cake?

4. What new things did you learn by trying this experiment?

Extra Ideas

- If desired, eat the rest of the cake immediately or freeze for later use.
- The cake made with aspartame can be used as a "shortcake" with a fruit topping. Share with class.
- Run any remaining cake through a food processor fitted with a steel blade to make crumbs. Use in pie crust or as a topping for a crumble.
- Publish your results by writing a summary of this experiment and your conclusions in your Food Science Journal.
- Adjust baking times for dark-colored baking pans.
- Prepare a cake with sucralose. What were the results? How does it compare to the other prepared cakes?
- Research other sugar substitutes during class time. Present your findings to the class.

Name ______________________ Date __________ Class __________

Food Science

Experiment 21

On the Rise—Shortened Cakes

Objective

- To observe how different amounts and types of chemical leavening agents affect shortened cakes.

Text Reference

- *Food for Today*, Unit 9, Ch. 44, 46

Look for These Terms

- *chemical leavening agent*: A substance that uses a chemical reaction between acid and base ingredients to produce carbon dioxide gas, making baked products rise.
- *double-acting baking powder*: A chemical leavening agent that produces carbon dioxide when liquid is added and again when heat is applied.

Background Information

Two commonly used *chemical leavening agents* are baking soda and baking powder. Baking soda must be used with an acid ingredient, such as sour milk. The soda is a base and combines with the acid in the milk to form carbon dioxide. Carbon dioxide expands when it is heated, causing baked products to rise.

When an acidic liquid is added to a batter containing baking soda, the soda and acid react immediately. Therefore the batter should be placed in the oven as soon as possible. Otherwise, the carbon dioxide escapes before the baking process starts and the product does not rise properly.

Baking powder is a combination of a dry base and a dry acid. When liquid is added, the base and acid react, giving off carbon dioxide. *Double-acting baking powder* reacts a second time in the heat of the oven.

In this experiment, your class will prepare three variations of a simple cupcake recipe. One version uses 1 tsp. (5 mL) baking powder, another uses 3 tsp. (15 mL) baking powder, and the third uses baking soda and cream of tartar (a dry acid). You will observe how each of these variations affects the appearance, texture, and flavor of the finished product.

Supplies

_____ 1 cup (250 mL) cake flour

_____ ½ cup (125 mL) granulated sugar

_____ ONE of the following as directed by your teacher:

- _____ 1 tsp. (5 mL) double-acting baking powder
- _____ 3 tsp. (15 mL) double-acting baking powder
- _____ ¼ tsp. (1 mL) baking soda and ½ tsp. (2 mL) cream of tartar

_____ ¼ cup (50 mL) butter or margarine

_____ 1 egg

_____ ¼ cup (50 mL) milk

_____ 1 tsp. (5 mL) vanilla

_____ muffin tin for 4 cupcakes

_____ 4 muffin tin liners of the same color (but of a different color than the other groups are using)

_____ 2 mixing bowls

_____ mixing spoon

_____ rubber spatula

_____ liquid measuring cup

_____ sifter

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_____ dry measuring cups
_____ measuring spoons
_____ large spoon
_____ cooling rack
_____ 2 small paper plates
_____ 2 adhesive labels
_____ pen, pencil, or marker
_____ sharp knife
_____ cutting board
_____ ruler

Procedure

_____ 1. Preheat oven to 350°F (180°C).

_____ 2. Line muffin tin with the paper liners. (If you do not have colored liners, use a nontoxic marker to mark plain muffin liners.)

_____ 3. In a mixing bowl, sift together flour, sugar, and ONE of the following as instructed by your teacher:

- _____ A. 1 tsp. (5 mL) double-acting baking powder.
- _____ B. 3 tsp. (15 mL) double-acting baking powder.
- _____ C. ¼ tsp. (1 mL) baking soda and ½ tsp. (2 mL) cream of tartar.

_____ 4. Set the dry mixture aside.

_____ 5. Use the mixing spoon to cream butter or margarine in the second bowl.

_____ 6. Beat the egg, milk, and vanilla into the creamed butter.

_____ 7. Add liquid ingredients to dry ingredients all at once.

_____ 8. Beat with a mixing spoon only until the batter is smooth.

_____ 9. Spoon batter into the four paper liners in the muffin tin. Fill the liners no more than ⅔ full. If you have more batter, use extra liners and make more cupcakes.

_____ 10. Write the name of the liner color in the appropriate blank on the Observation Chart. Write the liner colors used by the other groups in the appropriate spaces. Circle the letter of the variation you prepared.

_____ 11. Bake in the preheated oven at 350°F (180°C) for 15 minutes.

_____ 12. Mark the two adhesive labels according to the variation you made: "A—1 tsp. (5 mL) Baking Powder"; "B—3 tsp. (15 mL) Baking Powder"; or "C—Baking Soda/Cream of Tartar."

_____ 13. Fasten the adhesive labels to the paper plates, as close to the edge as possible.

_____ 14. When the cupcakes are done, remove them from the oven.

_____ 15. Remove cupcakes from pan and cool on cooling rack.

_____ 16. Place one whole uncut cupcake on the first paper plate. Using a sharp knife and a cutting board, cut another cupcake in half. Place the halves on the paper plate with the whole cupcake.

_____ 17. Cut remaining two cupcakes in small pieces for class members to sample. Place these pieces on the second paper plate.

_____ 18. Place paper plates so class members can observe and sample your cupcakes.

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■ Observations ■

_____ 1. With a ruler, measure the height of a cupcake in each sample. Record your observations in both inches and centimeters in the appropriate blanks on the Observation Chart.

_____ 2. Observe the outside color and texture of a cupcake in each sample. Record your observations on the Observation Chart.

_____ 3. Examine the color and texture of the inside of the cut cupcakes. Record your observations in the appropriate blanks on the Observation Chart.

_____ 4. Taste each of the three samples, noting texture and flavor. Record your observations in the appropriate blanks on the Observation Chart.

OBSERVATION CHART

Characteristics	**A** **1 tsp. (5 mL)** **Baking Powder**	**B** **3 tsp. (15 mL)** **Baking Powder**	**C** **Baking Soda/** **Cream of Tartar**
Color of liner			
Height	**in.** **cm**	**in.** **cm**	**in.** **cm**
Outside: **Color**			
Texture			
Inside: **Color**			
Texture			
Flavor			

(Continued on next page)

Conclusions

1. Based on your observations, which leavening agent produced the best quality cupcake? Explain.

2. Which cupcakes did not rise properly? Explain.

3. If you were making a bread or cake recipe using buttermilk, what kind of leavening would you use? Why?

4. Did you notice any difference in the cupcakes made with baking powder and those made with baking soda? Explain.

5. Besides leavening, what factors have you found to affect how baked goods rise?

Extra Ideas

- Experimental cupcakes may be shared with the class.
- Slice cupcakes and use as a base for desserts such as a shortcake.
- Publish your results by recording a summary of this experiment and your conclusions in your Food Science Journal.
- Develop a cupcake recipe of your choice. Make it look like a beehive and add an edible bee to the top! What kind of candy can be made to look like a bee? Try some fruit chews and chocolate rolls. Vote on the best looking beehive cupcake, then eat them as a treat.
- Meet with a professional baker and discuss leavening options. Bring notes back to class and share discussion points.

Name ______________________ Date ____________ Class ______________

Food Science

Experiment 22

The Pectin Question

Objective
◆ To determine the effects of pectin and sugar when making jelly.

Text Reference
◆ *Food for Today*, Unit 6, Ch. 29
◆ *Food for Today*, Unit 7, Ch. 30

Look for These Terms
◆ *gel*: A semi-rigid, elastic mass consisting of liquid trapped in a network of solid particles
◆ *pectin*: A carbohydrate found in many fruits that has the ability to gel liquid under certain conditions

Background Information

Jelly and jam are examples of a *gel*. A gel is a semi-rigid, elastic mass. It is a special combination of solid and liquid. The solid particles are linked together into a network, and the liquid is trapped in the spaces between.

Pectin is a carbohydrate that occurs naturally in the cell walls of most plants, but especially in fruit. When pectin is cooked with sugar and acid, it forms a network that traps water, making a spreadable jelly or jam.

The right amounts of acid and sugar are needed to help pectin do its work. The correct level of acid changes the nature of the pectin so it will gel. Sugar molecules attach themselves to the water that is present, freeing the pectin molecules so they can bind with each other.

In this experiment, your class will prepare three variations of basic jelly. One version is made without pectin but with 1 cup (250 mL) sugar. Another is made with pectin and 1 cup (250 mL) sugar, and the third with pectin and 2 cups (500 mL) sugar. You will observe how these differences in ingredients affect the finished products.

Supplies

_____ 2½ Tbsp. (40 mL) powdered pectin, if needed for your variation
_____ ¼ cup + 2 Tbsp. (80 mL) (OR 3 oz. [85 g]) frozen apple juice concentrate, thawed
ONE of the following as directed by your teacher
    _____ 1 cup (250 mL) sugar
    _____ 2 cups (500 mL) sugar
_____ 1 cup (250 mL) cold water
_____ 1 heavy 2-3 qt. (2-3 L) saucepan
_____ 1 slice white bread
_____ 1-pt. (0.5-L) glass jelly jar or other heat-resistant glass
_____ large metal cooking spoon
_____ 5 adhesive labels
_____ 3 small paper plates
_____ pen or marker
_____ liquid measuring cup
_____ dry measuring cups
_____ measuring spoons
_____ rubber spatula
_____ 3 small spoons
_____ 3 knives

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■ Procedure ■

_____ 1. Mark three adhesive labels as follows: "A—No Pectin"; "B—Pectin + 1 cup (250 mL) Sugar"; and "C—Pectin + 2 cups (500 mL) Sugar."

_____ 2. Fasten to the rims of the three small paper plates.

_____ 3. Mark two labels with the name of the variation assigned to you by your teacher.

_____ 4. Fasten one label to the handle of the saucepan.

_____ 5. Fasten one label to the jelly jar or glass.

_____ 6. Put thawed apple juice concentrate in the saucepan.

_____ 7. Add ONE of the following as instructed by your teacher:

- _____ cold water (A).
- _____ cold water and powdered pectin (B and C).

_____ 8. Stir until completely mixed.

_____ 9. Cook over high heat, stirring constantly, until bubbles form around the edge.

_____ 10. Add ONE of the following as instructed by your teacher:

- _____ 1 cup (250 mL) sugar (A and B).
- _____ 2 cups (500 mL) sugar (C).

_____ 11. Boil for 1 minute, stirring constantly.

_____ 12. Skim off any foam with a large metal cooking spoon.

_____ 13. Remove from heat and pour into your jelly jar.

_____ 14. Cool. (If necessary, jelly can be cooled in the refrigerator.)

_____ 15. Place your jelly where it can be observed and tasted by all class members.

■ Observations ■

_____ 1. Spoon a small portion of each sample of jelly onto the proper paper plate, using a separate spoon for each sample.

_____ 2. Observe the consistency of each sample. Record your observations in the appropriate blanks on the Observation Chart. Circle the letter of the variation you prepared.

_____ 3. Break the slice of bread into 3 pieces.

_____ 4. Spread one piece with sample "A—No Pectin" and note how well the jelly spreads on the bread. Record your observations in the proper blank on the Observation Chart.

_____ 5. Taste sample "A" with the bread and then taste a small amount from the spoon. Record your observations in the proper blank on the Observation Chart.

_____ 6. Spread another piece of bread with sample "B—Pectin + 1 cup (250 mL) Sugar." Record your observations in the proper blank on the Observation Chart.

_____ 7. Taste sample "B" with the bread and then taste a small amount from the spoon. Record your observations in the proper blank on the Observation Chart.

_____ 8. Spread another piece of bread with sample "C—Pectin + 2 cups (500 mL) Sugar." Record your observations in the proper blank on the Observation Chart.

_____ 9. Taste sample "C" with the bread and then taste a small amount from the spoon. Record your observations in the proper blank on the Observation Chart.

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OBSERVATION CHART			
Characteristics	**A No Pectin 1 cup (250 mL) Sugar**	**B Pectin and 1 cup (250 mL) Sugar**	**C Pectin and 2 cups (500 mL) Sugar**
Consistency			
Spreadability			
Flavor			

Conclusions

1. What was the main difference between the three jellies?

____
____
____

2. Explain the differences in quality in relation to the amount of pectin and sugar used.

____
____
____

3. Which jelly did you prefer? Why?

____
____
____

Extra Ideas

- After you have completed the experiment, you can make a jelly from version "A": add 2½ Tbsp. (40 mL) powdered pectin to the mixture and follow Steps 8-14.
- The jelly has not been processed, so it must be refrigerated. Do not store at room temperature. Use as soon as possible.
- Publish your results by recording a summary of this experiment and your conclusions in your Food Science Journal.
- Research the difference between jelly and jam. Report your findings.
- Develop a jam or marmalade recipe. Prepare it at home and bring in samples to share in class.
- Find other recipes that use pectin. Make a list of your findings.
- Research low-sugar pectins. Do they gel differently? Is there a difference in the shelf-life or stability of products made with low-sugar pectin?

Name ______________________________ Date ____________ Class ______________

Food Science

Experiment 23

Bacteria in Numbers—Clean Hands

Objective

◆ To develop an awareness of bacteria growth from individual hand samples

Text Reference

◆ *Food for Today*, Unit 5, Ch. 20

Look for This Term

◆ *pathogenic bacteria*: Disease or illness-causing bacteria.

Background Information

Personal Hygiene is not just a personal issue—personal hygiene can affect those around you. By practicing good habits, you can prevent the spread of harmful bacteria. Because hands are a prime target for transmitting bacterium, learning to wash hands properly is a must. The 20-second scrub has a proven track record.

Remember to use warm water and soap. Scrub hands for 20 seconds. Use a fingernail brush to clean debris from well-trimmed fingernails. While the 20-second scrub should follow any handling of contaminants, it is essential when handling food. Hands should always be washed following toilet use, handling animals, blowing your nose, or touching any area of your face and hair.

Bacteria can spread easily from coughing, sneezing, an open wound, or allowing stained clothing that has come in contact with others. Being aware and practicing good personal hygiene is beneficial to you and others. For those that handle food, hands should be washed before and after any food contact. Keeping hands properly washed and dried is a *must* when handling eggs, poultry, and raw meats.

Supplies

_____ sterile petri dish filled with agar

_____ permanent marking pen

_____ fingernail file

_____ adhesive labels

_____ weekly chart

Procedure & Observations

_____ 1. On the bottom of an agar-filled petri dish, use a permanent marking pen to write your name.

_____ 2. Using a fingernail file, scrape the palms of your hands with the tip of the fingernail file. Then scrape the underside of your nails and place any debris on the agar in the petri dish.

_____ 3. Cover the petri dish with the lid.

_____ 4. On your observation chart (shown on the next page), record the source from which you took the sample.

_____ 5. Incubate the petri dish at room temperature for four days. Make sure the dishes are left in a place where they will not be disturbed.

_____ 6. Record your observations daily on your observation chart. Discuss daily findings with other classmates.

_____ 7. On day four, compare all of the petri dishes. What were the results? Make sure your results are documented in your data chart.

_____ 8. Dispose of used petri dishes, following your teacher's directions.

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OBSERVATION CHART				
Assignment:	**Agar Day 1 Date:**	**Agar Day 2 Date:**	**Agar Day 3 Date:**	**Agar Day 4 Date:**
Observations:	**Observations:**	**Observations:**	**Observations:**	**Observations:**

(Continued on next page)

Conclusions

1. Were you able to get an adequate scraping?

2. Were there radical differences between day one and four? If so, explain.

3. What kind of results did you expect? Can you attribute a reason for the results?

4. What steps would you take to change the results? What procedures would you implement?

(Continued on next page)

Extra Ideas

- Try the 20-second scrub and then perform the experiment again with another petri dish. Repeat the eight steps under “Procedure,” and record your findings.
- Try the experiment with wiping door handles at school. Repeat the eight steps under “Procedure” and record your findings.
- Develop a list to reduce bacterium at school and at home. Share your list with the class.
- Research other substances that promote bacteria growth (like agar). List your findings.
- Develop a different observation chart for your experiments. What would you include? Share your sample with classmates.
- How can you help minimize the likelihood of any foodborne illness? Participate in a discussion with your class regarding safe and sanitary procedures.
- Produce a drawing of the 20-second hand scrub. Post your drawing in the school cafeteria. Request that all of the class drawings be posted in the school building.
- Try the experiment with your dog or cat. Bring in results from home.
- Make a chart showing a comparison between Experiment #23 and an animal sample.

Name ____________________ Date __________ Class __________

Food Science

Experiment 24

Clear That Broth

Objective
- To observe the magnet-like effect of egg whites as they attract particles from a clouded broth.

Look for This Term
- *coagulation*: The transformation of proteins from a liquid to a more solid state; usually achieved with the assistance of heat.

Text Reference
- *Food for Today*, Unit 7, Ch. 35

Background Information

Preparing flavorful, clear broth can be a lot of work. Ingredients that are placed together in a heated water bath are soon enveloped by loose food particles that leave a cloudy residue. Trapping those food particles leaves a clear and flavorful broth. Egg whites carefully whisked into the heated broth work like a magnet trapping the particles as the protein of the egg coagulates. The egg-white foam rises to the top and forms a covering. When this foam is removed, a clear broth free of floating bits and pieces remains behind.

Supplies

_____ broth recipe

_____ large saucepan or stock pot (depending on amount of broth)

_____ egg whites

_____ wire whisk

_____ slotted spoon

_____ observation chart

Procedure & Observations

_____ 1. In a large saucepan or stock pot, heat the broth ingredients.

_____ 2. Cook the broth according to the recipe directions.

_____ 3. When the broth has infused with the vegetables, (meat), spices, herbs, and other ingredients, and the food particles are visibly floating throughout, carefully whisk the egg whites into the broth.

_____ 4. When white foam appears as a covering over the top of the broth, remove it with a slotted spoon.

_____ 5. Once the foam is removed, a clear broth will remain. The broth can be served or cooled down for another time.

_____ 6. Is the broth completely clear? Document your observations on the Observation Chart on page 106.

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OBSERVATION CHART				
Recipe Name:	**Ingredients:**	**Procedure:**	**Observations:**	**Final Results:**

(Continued on next page)

Conclusions

1. Were you able to whisk the egg whites easily? Did they begin to adhere to particles immediately?

2. Was the foam easily removed?

3. Was the broth perfectly clear? Describe its appearance.

4. Did the egg whites affect the flavor of the broth?

Extra Ideas

- Try this experiment with a chicken stock or broth.
- Try this experiment with a beef stock or broth.
- Try this experiment with a vegetable stock or broth.
- Will this experiment work with whole eggs?
- Freeze ice cube trays with clear stock (these can be added for flavor in stock and sauces).
- Roast the bones of beef, veal, lamb, chicken, or buffalo in the oven before adding them to the broth (they will add a rich, deep flavor).

Name ______________________ Date __________ Class __________

Food Science

Experiment 25

Hold That Curdle

Objectives

- ◆ To observe what happens when cooking a recipe with milk and cream at too high a temperature.
- ◆ To observe what happens when an acid food is added to milk.

Look for These Terms

- ◆ *curdling*: When milk separates and forms liquids and solids.
- ◆ *Tempering*: To prevent curdling by bringing one food to the right temperature or consistency before mixing it completely with another.

Text Reference

- ◆ *Food for Today*, Unit 7, Ch. 34

■ Background Information ■

Cooking with milk or cream can prove to be difficult. One of the biggest disappointments that can occur during cooking is when a delicious custard "breaks" (or curdles) or a homemade tomato soup separates before serving it. Excessive heat, excessive cooking, and the presence of acids can make a milk and cream dish a disaster. If you have ever seen a cup of coffee or tea curdle, it occurs because of an acidic reaction. Was the cream bad? Did the tea have lemon in it? When cream is not fresh, its lactic acid content increases. When that happens, the coffee will curdle (coffee has acid in it too). The same separation occurs when lemon juice or a lemon slice is present in a cup of tea.

■ Supplies ■

_____ Recipe and ingredients for a cooktop custard

_____ 1 cup of milk (for the second part of the experiment)

_____ 2 saucepans

_____ Measuring cup

_____ lemon juice

_____ 2 mixing spoons

_____ Observation chart

■ Procedure & Observations ■

_____ 1. Prepare a cooktop custard recipe. Instead of following recipe instructions, set the heat on medium-high. Stir as directed. What happens to the custard?

_____ 2. Document your observations on your Observation Chart. Is the custard edible? Is it salvageable? Is it prepared according to your tastes?

_____ 3. In the second saucepan, add the cup of milk.

_____ 4. Bring the milk to warm; add lemon juice.

_____ 5. Stir the mixture. Observe what is happening in the mixture over a period of five minutes. How has the mixture changed?

_____ 6. Record your observations. Discuss them with other classmates.

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OBSERVATION CHART				
Recipe Name:	**Ingredients:**	**Procedure:**	**Time:**	**Final Results:**

(Continued on next page)

Conclusions

1. Did the custard burn? Did it curdle? Record your findings.

2. What kind of results did you expect? Can you attribute a reason for the results?

3. What steps can you take to change the results? What procedures can you implement?

4. Repeat questions 1–3 for the second part of the experiment. Write conclusions in paragraph form.

Extra Ideas

- Make a list of foods that have *intentional* curds and bring in a sample. Determine the popularity of curd-laden foods. Are these foods appealing and interesting to most high school students?
- Find at least one reference to "curds" in a song, a nursery rhyme, or a children's story. Bring your findings into class.
- Develop an experiment of your own. Prepare it in the same form as Experiment #25.
- Prepare an oven-baked custard. What were your observations? Hold a class discussion on this topic.
- Prepare a warm cup of milk (do not drink it). Add a tablespoon of salt while it is warming. What happens to the milk? Present your findings. Did your classmates record similar observations? Why or why not?
- Research fresh pineapple and its curd-creating property. Name the enzyme that creates curds. Bring your research into class, and compare your findings to those of your classmates.
- Prepare several vegetables in separate saucepans filled with milk. Which of the vegetables caused the milk to curdle? Which ones did not? Fill out an Observation Chart with your results.