Butter Cakes

Unit: Preparing Foods

Problem Area: Baking and Pastry

Lesson: Butter Cakes

Student Learning Objectives.

Instruction in this lesson should result in students achieving the following objectives:

1. **Summarize basic butter cake ingredients and equipment.**
2. **Prepare butter cakes.**
3. **Analyze physical changes and chemical reactions that occur in butter cake preparation.**

Resources.

The following resources may be useful in teaching this lesson:

E-unit(s) corresponding to this lesson plan. CAERT, Inc. http://www.mycaert.com.

Better Homes and Gardens New Cookbook, 16th ed. Better Homes & Gardens. 2016.

"The Complete Guide: Bundt® Cakes," *King Arthur Flour.* Accessed May 22, 2018. http://www.kingarthurflour.com/guides/bundt-cake/.

"Discover, Learn, Bake Your Best," *King Arthur Flour.* Accessed May 22, 2018. http://www.kingarthurflour.com/learn/.

Gisslen, Wayne. *Professional Baking,* 7th ed. John Wiley & Sons, Inc., 2016.

"Heritage," *Nordic Ware.* Accessed May 22, 2018. https://www.nordicware.com/heritage/.

"High-Altitude Cake Baking," *Allrecipes.com*. Accessed May 22, 2018. http://dish.allrecipes.com/high-altitude-cake-baking/.

Hobbs, Kelly Marie. "Ingredient Functions—Baking," *Prezi Inc.* Accessed May 22, 2018. https://prezi.com/yti6n6kvu4zr/ingredient-functions-baking/.

Schmidt, Wayne. "How to Bake the Best Cupcakes," *waynesthisandthat.com* Accessed May 22, 2018. http://www.waynesthisandthat.com/how%20to%20make%20the%20best%20cupcakes.html.

Labensky, Sara R., Priscilla A. Martel, Eddy Van Damme. *On Baking: A Textbook of Baking and Pastry Fundamentals,* 3rd ed. Pearson, 2016.

Levy Berenbaum, Rose. *The Cake Bible*. Kindle ed. Houghton Mifflin Harcourt, 2016.

Equipment, Tools, Supplies, and Facilities

- ✓ Overhead or PowerPoint projector
- ✓ Visual(s) from accompanying master(s)
- ✓ Copies of sample test, lab sheet(s), and/or other items designed for duplication
- ✓ Materials listed on duplicated items
- ✓ Computers with printers and Internet access
- ✓ Classroom resource and reference materials

Key Baking Terms.

The following terms are presented in this lesson (shown in bold italics) and in the corresponding E-unit titled "Butter Cakes: Ingredients and Preparation":

- all-purpose flour
- baker's percentage
- blending method
- butter cake (shortened cake)
- cake flour
- creaming
- creaming method
- emulsifier
- emulsified shortening
- fats
- foam
- formula
- gluten
- lipids
- mise en place
- mixing
- nut flour
- recipe
- saccharide
- salt
- salted sweet cream butter
- scaling
- shorten
- triglyceride
- unsalted sweet cream butter
- vegetable oil
- vegetable shortening

Key Science Terms.

The following terms are presented in this lesson (shown in bold italics) and in the corresponding E-unit titled "Butter Cakes: Baking Science":

- absorption
- caramelization
- carbon dioxide (CO_2)
- chemical reaction
- condensation
- conduction
- convection
- emulsion
- endothermic reaction
- evaporation
- exothermic reaction
- gluten
- heat transfer
- homogeneous mixtures
- hydrogenated fats
- hydrogenation
- hydrolysis
- hygroscopic
- immiscible
- invert sugar
- Maillard reaction
- osmosis
- physical change
- radiation
- relative humidity (RH)
- surface area
- trans-fatty acid (trans fat)

Interest Approach.

Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

Begin this lesson with a discussion of the idioms related to cake.

DISCUSSION: *We've all heard the following idioms, "It's a piece of cake." "You take the cake." "It's the icing on the cake." What do these phrases mean? Allow several students to give their interpretation of these phrases.*

REVIEW: *[Use VM–A to project the three cake idioms.] "It's of a piece of cake" means the same as "it's a cinch," in other words, the task should be easy. Presumably the idiom came about because eating a piece of cake is easy and pleasurable. It has also been associated with wealth. ("Let them eat cake.")*

"That takes the cake," began as a signal that something was the worst or most extreme version of its kind. (For example, as an act of exasperation such as, "I can't believe she made that fielding error again! That takes the cake!")

"It's the icing on the cake" is a phrase meaning that something is making an already good situation even better. (For example, "I found a great job, and I get to live in a neighborhood I love—it's the icing on the cake.")

DISCUSSION: *Next, have students look at a few examples of butter cakes on Epicurious at https://www.epicurious.com/search/butter%20cake. Then, ask a few discussion questions based on the images you selected from Pinterest.*

- *Which butter cake picture was most interesting to you? What made it interesting?*
- *If you prepared that cake, do you think making it "will be a piece of cake?" What would explain your response?*
- *Other than a box mix, how many have previously made a butter cake from scratch? If so, what types?*
- *Baking is a science. What are the basic science principles you need to know to make great butter cakes? [NOTE: Make a list of baking-science principles students perceive as part of making a butter cake. After LS–A, ask students to update the list of science principles based on their successes or failures with their first butter cake. (Repeat after LS–B.)]*

This lesson is designed to expand your knowledge about the baking science and artistry of creating tender butter cakes.

CONTENT SUMMARY AND TEACHING STRATEGIES

Objective 1: Summarize basic butter cake ingredients and equipment.

Anticipated Problem: What is a butter cake? What are the four main ingredients in all butter cake recipes and formulas? What other ingredients are typically used in butter cakes? What standard equipment is required to make butter cakes from scratch?

I. ***Butter cake (shortened cake)*** is a rich, tender, moist, and dense baked good that has a high level of butter (or other fat) in its make-up. (Although shortening and other fats can be substituted, butter will be listed as the fat ingredient for most of this lesson.) The four main ingredients in all butter cakes include butter, sugar, eggs, and flour. The addition of butter distinguishes a butter cake from a foam cake. Butter cakes are uniquely American; although, they are patterned after heavy, rich, English pound cakes (one pound each of butter, flour, eggs, and sugar). Other butter cake ingredients can include leavening agents (usually baking soda or baking powder), sour milk, buttermilk, flavoring extracts, or salt (to enhance flavors). Due to the limited number of ingredients in butter cakes, the best results are achieved using high-quality butter, adding pure flavoring extracts, measuring and weighing accurately, and closely following recipe instructions. [NOTE: This lesson primarily addresses the baking of butter cakes from scratch (using a recipe), with a few references to the modification of butter cake mixes. However, besides some basic terms, the handling of quantity cake mixes (using a formula) is not addressed here. Also, all cake pan measurements are in inches, unless otherwise specified.] To appreciate the interaction of these ingredients, there are specific terms and characteristics associated with all parts of the cake recipe that should be considered.

A. FORMULA VERSUS RECIPE: Baking is science. Bakers use formulas to ensure consistent products. A formula is a general science and math construct that shows the relationship between given quantities. In baking, a ***formula*** is the written measurement of ingredients by weight (in pounds, ounces, kilograms, or milligrams). Weight measurement is essential when flours and sugars (anything sifted) are added to a baking formula. In contrast, a ***recipe*** is the written measurement of ingredients by volume, such as teaspoons, tablespoons, cups, dashes, and pinches—which are perfectly fine for small batches.

1. *Scaling:* ***Scaling*** is a baker's term for weighing out ingredients. Accurately measuring 4.54 cups of cake flour by volume is, at best, a guess; whereas, accurately weighing one pound of cake flour is precise. In baking and pastry formulas, all ingredients are based on percentages (ratios), and the percentages are what allow the baker to scale the batter up or down (doubling, tripling, etc.) in quantity.

2. *Baker's Percentage:* A ***baker's percentage*** (formula percentage) is the percentage of an ingredient in relationship to the amount of flour in the formula. For example, 1000 grams of flour, 660 grams of water, 20 grams of salt, and 10 grams of yeast are expressed in a baker's percentage as 100 percent flour, 66 percent water, 2 percent salt, and 1 percent yeast. In a baker's formula, all amounts are expressed in percent of the total flour weight; although, it is actually a ratio, as the percentages always add up to more than 100 percent. If a formula calls for 4 pounds of flour, then 4 pounds equals 100 percent. In the same formula, 2 ounces of baking powder equals 3.1 percent of the total flour weight. [NOTE: Go to the King Arthur Flour webpage, "Ingredient Weight Chart," at http://www.kingarthurflour.com/learn/ingredient-weight-chart.html.] A drawback to a baker's percentage is that gluten-forming flour proteins are not reflected in the formula. This can have an impact on the final product, so it may need to be adjusted. There are, however, many reasons to use a baker's percentage.
    a. It enables the baker to work with more precision (with only one unit of measure).
    b. It is easy to scale a formula up or down (doubling, tripling, etc.).
    c. It is easy to compare which formula is drier, sweeter, or saltier.
    d. The baker's percentage helps create uniform ingredient measurements for varying quantities per unit. (For example, 70 grams may be the weight of one to three eggs, depending on their size.)
    e. It also serves as a common language among all bakers and baking operations.

B. FLOUR BASICS: All-purpose wheat flour (mixed from hard and soft wheat) is the most commonly used flour for baked goods in the United States. French flour is made from soft wheat. Both hard and soft wheat contain very little germ or husks, and they keep longer than whole meal-type flours. Varying protein content affects the way flours react, so some dessert and pastry recipes may call for 2½ to 2¾ cups. In this case, the process is to measure and add smaller amounts first. Then, following the recipe directions, more flour can be added to create the desired condition (cleans the sides of the bowl, not sticky to the touch, etc.). On the other hand, butter cake recipes and formulas typically call for a specific amount of flour, such as 2½ cups.
    1. ***Gluten*** is an elastic protein found in wheat and cereal flours that gives batter and dough elasticity, strength, and rising ability. (It keeps baked goods from collapsing when removed from the oven.) Gluten stretches (when moistened) and expands to hold the gas produced by the leavening agent. It becomes a structural framework for baked products.
    2. The type of wheat (hard or soft) affects the amount of gluten content. Hard wheat (grown in the Midwest) has a high protein content and, as a result, produces more gluten. Soft wheat (grown in the South) has less protein content and produces less gluten. Baked products require different gluten content. Cakes, quick breads, and pastries require much less gluten formation (for a soft, fine texture) than yeast breads.

C. FLOUR FUNCTIONS: Flour adds, provides, and/or creates body (bulk or mass), structure, texture (tender and crumbly or firm and chewy), flavor, and gluten within the baked item.

D. FLOUR TYPES: The following flours are typically associated with butter cakes.

1. ***All-purpose flour*** is a blend of hard and soft wheat that can be bleached or unbleached. It is the most common flour used in the United States, and it is made up of 8 to 11 percent protein (gluten). It is used for quick breads, pastries, and some cakes. Flour that bleaches naturally (usually via oxygen) is called "unbleached," and flour that is chemically treated (by chlorine, bromates, or peroxides) is termed "bleached." Bleached flour has less protein than unbleached.
   a. In Europe, these chemicals are not allowed in flour.
   b. Bleached flours are best for pie crusts, cookies, quick breads, pancakes, and waffles.
   c. Unbleached flours are best for yeast breads, Danish pastry, puff pastry, strudel, éclairs, cream puffs, and popovers.
   d. Unbleached flour in the United States may still have been treated with a bromate. Read all ingredients carefully, or go to company websites for milling information.
2. ***Cake flour*** is a finely-ground, soft wheat flour with a high starch content. It is bleached with chlorine to allow it to absorb more water, which produces a fine, white crumb in cakes. Bleaching makes the flour slightly acidic. This has two effects: It sets the cake batter faster, and it distributes fat more evenly than other flours, which improves the texture. Cake flour is $7^1/_2$ percent protein (gluten). Its low gluten count produces tender cakes. Baked goods with a high sugar ratio benefit from the use of cake flour, because it is able to rise without collapsing (more so than products produced with all-purpose or other wheat flours). [NOTE: In a pinch, two tablespoons taken from a cup of wheat flour can be a substitute for cake flour.]
3. ***Nut flour*** is made from finely ground nuts, and it can be used to bake breads, cookies, cakes, and, especially, pastry crusts.

E. OTHER FLOUR FACTS: Flour is often used to prepare pans for cake batters and other baked goods to prevent sticking.

1. Preparing a pan for baking often requires a greased pan to be lightly coated with flour. That pan is then tapped to remove any excess flour. Some baking sprays already contain flour for this purpose.
2. All flours are different, and they work best when weighed. [NOTE: For information about measuring flour by volume see the "How to Measure Flour" video at http://www.kingarthurflour.com/learn/how-to-measure-flour.html.]

F. FAT BASICS: ***Fats*** are plant- or animal-based, oily ingredients that melt at low temperatures. Fats are compounds of carbon, hydrogen, and oxygen. ***Lipids*** are molecules that include fatty acids, triglycerides, cholesterol, and various nutrients. Fats are lipids found in animal and vegetable tissue. (From animals, butter and lard are produced. From vegetables, nuts, and legumes, oils and shortenings are

made.) Solid fats (butter, margarine, and hydrogenated products) remain solid near room temperature. Oils can solidify when refrigerated or cooled. A byproduct of creating hydrogenated shortenings is the production of trans-fatty acids (trans fat) that may cause a health risk. Shortenings are 100 percent fat. A half-and-half split with butter is a good shortening mixture. Four common fats can be used to make baked goods.

1. *Vegetable Shortening:* ***Vegetable shortening*** is a solid fat made from purified oils (soybean, peanut, corn, or cottonseed oil) that have been hydrogenated. Shortening is hydrogenated to make them solid at room temperature. Hydrogenation is a process of adding hydrogen molecules under pressure to solidify the liquid vegetable oils and absorb the oxygen from fatty acids. (This converts them to fats that are solid at room temperature.) Some shortenings may have added animal fats, emulsifiers, colorings, and flavorings (butter). Hydrogenated fats provide more volume for baked goods than butter. Shortening gets its name from its ability to ***shorten*** (tenderize) gluten strands, which increases the tenderness of the baked product. Fats with the greatest shortening power are lards, drippings, and cooking fats, but they tend to flavor a baked good in a dominating way.
2. *Vegetable Oil:* ***Vegetable oil*** is fat extracted from plants, fruits, or seeds. Examples of vegetable oils are coconut, corn, cottonseed, olive, palm, rapeseed (canola), safflower, soybean, and sunflower. Oils are liquid at room temperature, but when refrigerated, they may solidify. Vegetable oil is a triglyceride. A ***triglyceride*** is an ester derived from glycerol and three fatty acids, and it is the largest class of fats represented in the human diet. [NOTE: For more information about the properties of fat, see the MYcaert lesson and e-unit for CA B3–5.]
3. *Emulsified Shortening:* ***Emulsified shortening*** (a.k.a. cake, icing, or high-ratio shortening) is a hydrogenated fat that gives cake fine and moist textures. They allow bakers to add more sugar and liquid to a baked product than allowed by a regular vegetable shortening. Icing mixtures can have more sugar and stability with emulsified shortenings. As butter does not contain emulsifiers, it is not easily suspended in batters and icings. An ***emulsifier*** is an additive that reduces the tension between oil and water. It improves a cake's softness, texture, stability, volume, and shelf life.
4. *Butter:* ***Salted sweet cream butter*** is a dairy product that is churned (agitating cream to separate fat and water) from fresh, sweet cream, has an 80 percent fat content, and has been flavored with salt. European butters can contain up to 86 percent fat. ***Unsalted sweet cream butter*** (same as the salted variation, minus the salt) is used in many sweet or low-sodium recipes. Water and some milk solids comprise the remainder of butter's contents. Butter is different from shortening in two major ways. It has an enhanced flavor and melts in the mouth.
5. Margarine is made from fats or oils that are partially hydrogenated. Margarine uses an 80/20 ratio, 80 percent fat to 20 percent other ingredients. Margarine can replace butter in baking, but it does not give the baked goods a distinctive

buttery flavor. The use of reduced-fat substitutes or spreads for baking is not recommended, because the lower fat content does not produce the desired results.

G. FAT FUNCTIONS: Fats provide many functions in a cake.
   1. Flavor and richness (especially butter or lard)
   2. Moisture
   3. Tenderness (shortens gluten strands)
   4. Leavening (when creamed)
   5. Browning
   6. Emulsification
   7. Even distribution of added flavors (vanilla, almond, etc.)

H. EGG BASICS: Eggs (combined with flour) are a structural element in baking. Chicken eggs are the standard. All other types of eggs (duck, ostrich, etc.) are rarely used in baking and pastry formulas. Eggs are a valuable source of vitamins A, B, and D.
   1. Grade AA large eggs (about two ounces each, or eight per pound) are the most common size used in baked goods. Eggshell color does not affect how the egg functions in baking and pastry products.
   2. Egg weight is more accurate than the number of eggs used.
      a. A large egg white: About $1^{1}/_{3}$ ounces or $2^{2}/_{3}$ tablespoons
      b. A large egg yolk: About $^{2}/_{3}$ of an ounce or $1^{1}/_{3}$ tablespoons
      d. Eight whole large eggs: About 1 pound or 2 cups
   3. A fresh egg should have a nicely rounded yolk that is well centered in the white. The egg, still in its shell, should sink to the bottom of a water-filled container (good way to check freshness).
   4. Cracked eggs have a danger of salmonella and should be discarded.

I. EGG FUNCTIONS: Eggs provide many functions in the baking process.
   1. *Leavening:* Via air incorporation, egg whites contain lecithin, a protein that lines the outside of the air bubbles created during beating. These bubbles prevent the egg whites from collapsing.
   2. *Emulsification:* Eggs act as a binding agent that holds other ingredients together. Eggs are second to flour in providing structure to baked goods.
   3. *Moisture:* Eggs keep batters moist without having to add other liquids (which might make the batter too thin or collapse).
   4. *Color:* Egg yolks provide color to batter. An egg wash provides a glaze to baked goods that browns the surface (the Maillard reaction).
   5. *Flavor and Texture:* Eggs add a distinctive taste to baked goods, and the addition of yolks makes baked goods more tender. Eggs act as a thickening agent and provide texture.

J. EGG TEMPERATURE: Eggs are easiest to separate when they are cold. To beat whole eggs or egg whites to their greatest volume, they should be brought to an

internal temperature of 65°F to 75°F. A few butter-cake recipes have the egg yolks and egg whites beaten separately. Most butter cakes beat in the whole egg.

K. SUGAR COMPONENTS: Sugar is a carbohydrate that is soluble in water, usually crystalline in form, and sweet in taste. Sugars are produced from various types of plants, such as canes (sucrose), beets, sugar maples, and palms. In fact, most fruits and vegetables contain sugar (sucrose or fructose). Solid sugars include cane and beet sugars. Liquids can include honey, molasses, corn syrup, or various manmade liquid sweeteners produced for dietary purposes.

1. ***Saccharide*** is the scientific name for sugar (or an organic compound containing sugar). Sugars and other sweeteners add taste, tenderness, color, and aroma to baked goods. [NOTE: Reducing more than one third of the sugar in a recipe will negatively affect the tenderness, moistness, brownness, and sweetness of the product. It may also change some of the scientific reactions that occur during preparation.]
2. The various grinds of solid sugar (such as granulated, powdered, superfine, or brown) impact finished products. Butter-cake batter is typically produced with granulated or brown sugar. When baking, liquid sugars do not react in the same fashion as solid sugars. Consult a reference guide when substituting liquids for solids. [TIP: For cake batters that include brown sugar, sifting eliminates the small molasses beads that sometimes fail to melt during baking.]
3. Sugar by weight is more accurate than sugar by volume.
   a. A cup of granulated sugar is about 7 ounces.
   b. A cup of confectioners' (powdered) sugar is about 4 ounces.
   c. A cup of packed brown sugar is about 7½ ounces.
   d. A cup of molasses, honey, or corn syrup is about 12 ounces.

L. SUGAR FUNCTIONS: Sugar has many functions within cake batters. [NOTE: Artificial sweeteners do not provide the same browning, tenderizing, and moisture retention as natural sugars.]

1. Flavor
2. Tenderization
3. Color (caramelizes and aids in browning)
4. Feeds yeast organisms (aids in fermentation)
5. Moisture retention (sweetened baked goods stay moist longer than unsweetened types)
6. Allows better spreading of cake batter and cookie dough

M. SALT COMPONENTS: ***Salt*** is a crystalline compound (NaCl, sodium chloride) primarily used as a condiment that comes in two types—sea salt distilled from seawater and rock salt found in the earth. Sodium chloride (table salt) was the first salt discovered by humans. Iodized salt (table salt with added iodine) has been the salt most often utilized in American cooking; however, sea salt has become more popular over the last few years.

N. SALT FUNCTIONS: Salt has many functions within cake batters.

1. Flavor (heightens the flavor of other ingredients, balances sugar)

2. Slows yeast fermentation, keeping air bubbles small and uniform in size
3. Toughens the texture of soft fat-and-sugar mixtures
4. Strengthens gluten protein (better texture)

O. LEAVENING COMPONENTS: Leavening is the production of gas in a dough or a batter through an agent, such as steam, air, eggs, baking soda, baking powder, a starter, or yeast. The leavening agent causes expansion in the batter by releasing gases within the mixture. Chemical leavening agents (baking soda and baking powder) produce CO_2 gas that helps products rise. Leavening is important in baked goods. Not only does it cause a baked product to rise, but it provides added flavor. [NOTE: Leavening agents are discussed in detail in CA C8–2, "Leavening Agents."]

1. *Steam:* While baking, moisture from batter is converted to steam. Butter cakes use steam as part of their leavening and lift. [TIP: The preheating of the oven encourages the greatest production of steam leavening.]
2. *Air:* Mechanical incorporation of air occurs during batter mixing, such as whipping, beating, or folding. Air leavening occurs when this vigorous mixing entraps air, creating bubbles that produce foam. All butter cakes should be beaten (and sometimes creamed) to add air leavening.
3. *Chemical:* Chemical leavening agents (baking soda, baking powder) produce a gas that helps the product rise. Chemical leavening agents are highly utilized in butter cakes.
    a. Baking soda: Baking soda (sodium bicarbonate) is a chemical leaven when combined with an acid. It creates tiny bubbles of carbon dioxide that push against the batter and cause it to expand (leaven, rise). Baking soda reacts with liquids, including sour milk, yogurt, buttermilk, sour cream, and molasses. Because baking soda only reacts once (single-action), it is often added to the dry ingredients first. Then, when wet and dry ingredients come together, the cake must be panned and baked as quickly as possible. [TIP: Mise en place is essential for a beginning baker using baking soda.]
    b. Baking powder: Baking powder is a chemical leaven composed of baking soda, a dry acid (such as cream of tartar), and a starch (such as cornstarch) to prevent lumping. Because of the added acids, baking powder will react on its own when wet. For baking powder leavening to occur, two elements must be available—an acid and an alkaline—that react separately in the presence of moisture. This combination forms gases (tiny bubbles in the batter) that expand for leavening. The most common form of baking powder is a double-acting variety, which has two dry acids. In double-action, the first acid reacts in the cold (room temperature) batter, and the second one reacts in the oven at an approximate temperature of 140°F. This ability to react twice makes baking powder a good choice for most baked products.

P. LIQUID BASICS: Butter cakes incorporate various types of liquids, including water, milk, buttermilk, light and heavy creams, sour cream, yogurt, fruit purées, and juices. Liquids are needed for chemical changes in structure and texture. When liquid evaporates under the dry heat of an oven, it produces steam. In turn, air

bubbles develop and increase the volume of the baked good. Like eggs and flour, liquids are more accurate when weighed. (Two cups of water and two cups of molasses are the same volume but different weights.) The metric system is preferred for measuring liquid, as it does not differentiate between fluids and solids—a gram is a gram and a kilogram is a kilogram.

Q. LIQUID FUNCTIONS: Liquids have many functions within baked goods.
   1. Moisture
   2. Flavor (milks, creams, fruits, juices, yogurt, or sour cream)
   3. Add color (browning from milk and fruit sugars)
   4. Leaven with steam
   5. Hydrate proteins, starches, gelatins, and leavening agents
   6. Activate yeast organisms
   7. Mix with flour for proper gluten development
   8. Aid in binding (especially in quick breads and muffins)

R. FLAVORINGS AND ADDED INGREDIENTS: In small quantities, flavorings and aromatics can add something special to a cake. Flavorings may include extracts (concentrated oils or essences diluted with alcohol), natural liquids (such as vanilla, almond, or cherry, also derived from concentrated oils), seeds and beans (vanilla, nutmeg, chocolate, coffee), and spices (like cinnamon, ginger, cloves, or nutmeg). Flavorings enhance (or fundamentally change) the taste of baked goods. Other added ingredients can include citrus (and other juices), nuts, chips, coconut, cherries, apples (and other fruits), chocolate, and vegetables.

S. HAND TOOLS AND EQUIPMENT: Basic hand tools and equipment are necessary for creating a well-mixed, balanced, and evenly-baked item.
   1. *Mixer:* Stand mixers sit on a tabletop or the floor and have several attachments (flat beater, dough hook, wire whip). Butter cakes primarily use flat beater and wire whip attachments (only if beaten egg whites are folded into the batter).
   2. *Scales:* Platform, digital, or balance scales are used to accurately measure ingredients. Platform scales are often used to measure moist ingredients, and balance scales measure dry ingredients. Digital scales are best to measure small amounts (spices, herbs, leavening agents) or portions (such as two ounces of batter per cupcake).
   3. *Spatulas:* Numerous spatulas are available, with most used for stirring, scraping, or icing.
      a. Wooden spatulas are very practical for stirring. The flat surfaces easily scrape off the edge of a pan. Also, egg mixtures (such as custard fillings) can be prepared with a wooden spatula.
      b. Rubber scrapers are used to remove all traces of dough and batter from a bowl or vessel. They are also used to gently fold beaten egg whites or meringue into a batter or dough.
      c. Metal icing spatulas (straight and offset) are used to ice many types of cakes.

4. *Cutting Boards:* Marble, polyurethane, and wooden cutting boards are used to protect table surfaces and reduce contamination.
5. *Knives:* Paring knives are used for trimming. Chef knives are used to chop, section, or split. Slicers are used to section cakes and to trim edges from bar cookies.
6. *Hand Whips:* A metal-handled, multi-wire whisk is used to incorporate air into various products, such as eggs or heavy cream.
7. *Wooden Spoons:* Large wooden spoons are used in creaming, cake-batter mixing, and folding operations. Chefs and cooks often prepare chocolate mixtures, sauces, and glazes with a wooden spoon.
8. *Sheet Pans:* Straight-sided pans (full, half, and three-quarter sizes) are used to bake sheet cakes, pan cookies, or sponge cakes.
9. *Jellyroll Pans:* These straight-sided pans (15½ × 10½ × 1) are used to bake sponge cakes, especially jellyrolls.
10. *Rectangular and Square Pans:* Rectangular (9 × 13 × 1.5) and square (8 × 8 × 1.5) are common household pan sizes. These are primarily for small sheet cakes that are served directly from the pan.
11. *Layer-Cake Pans:* Layering pans are typically round, but could be square, rectangular, or other shapes. (They can vary up to 18 inches, but 9 × 9 × 2 or 3 is common.) Professional layer pans are used to make all types of two- and three-layer cakes. Some have loose bottoms for easy cake removal.
12. *Loaf Pans:* Loaf pans (9 × 5 × 3 or 10 × 4 × 3) are used for baking pound cakes, fruitcakes, and breads.
13. *Tube Pans:* These pans (9 × 3 is common) are used to make angel food cakes, Bundt® cakes, and chiffon cakes. Sometimes, these pans are fluted. Bundt® cakes are normally made with a butter cake batter.
14. *Springform Pans:* Springform pans (9 and 10 are common) have hinged sides and a removable bottom. They are typically used to bake cheesecakes, layered cakes, and frozen desserts.
15. *Scoops:* Scoops (or dippers—resemble ice-cream scoops) come in many sizes. Scoop numbers generally correspond to measures. Portions are based on a number of leveled scoops. [A scoop number of 100 means that 100 portions are found in a quart of batter. A scoop numbered 12 (each scoop contains a scant ½ cup) is typically used to portion cupcakes.]
16. *Liners:* Disposable parchment paper and reusable silicone pan liners are used in conventional, convection, and microwave ovens. Pan liners make cake layers easy to remove from pans. Silicone liners are reusable.
17. *Pastry Brush:* Wooden- or plastic-handled brushes are used to pre-grease pans or to brush crumbs from a cake (before icing).

Teaching Strategy: *VM–A to introduce the butter-cake lesson. (See the "Interest Approach" section above.) Facilitate a discussion of whom in history said, "Let them eat cake?" Although the phrase is attributed to Marie Antoinette, there is no record of her making the statement. When told the peasants have no bread, the wealthy and*

privileged jokingly responded, "Let them eat something else. Let them eat cake." The phrase is still used to illustrate how detached and clueless some individuals are about their surroundings. [For more information, see David Emery's ThoughtCo article at https://www.thoughtco.com/let-them-eat-cake-er-brioche-oh-nevermind-3299161 about the history of the phrase.]

Use VM–B and VM–C to review butter-cake ingredients. Use VM–D to review basic baking ingredients and their functions in butter cakes. Use VM–E to illustrate butter-cake-preparation equipment and tools.

Homework Assignment: Have students take inventory of their cabinets at home. How many of the basic ingredients to make butter cakes are available? Does a relative have more or less of the basic ingredients?

***ACTIVITY:** Consider each piece of equipment used to make a butter cake. Make a data table. Record the number of students in the class who have used each piece of equipment. Rank the equipment from most to least used.*

***DISCUSSION:** Discuss the minimal equipment requirements for someone wanting to bake butter cakes (perhaps they moved into a new apartment or dorm room with no baking supplies). Have students explain why each piece of equipment is needed. Ask them to differentiate between necessary and optional equipment.*

Objective 2: Prepare butter cakes.

Anticipated Problem: What is mise en place? What are butter cake preparation methods? How does "creaming" work? How are cake pans prepared? How are butter cakes tested for doneness and cooled?

II. Many tasks, steps, ingredient preparations, tools, and equipment pieces should be discussed when preparing a butter cake.

A. MISE EN PLACE: Before mixing, the baker must follow the rules of mise en place. ***Mise en place*** is a French cooking term that means "to set up" or "to arrange." The baker should:

1. Read the entire recipe.
2. Collect all of the ingredients and allow them to come to room temperature (with the exception of heavy cream, which should usually remain refrigerated until use).
3. Measure all ingredients accurately, preferably by weighing.
4. Follow processes requested by the recipe. This might include chilling a stainless steel bowl in the freezer (to whip heavy cream), ensuring ingredients are at room temperature, or pre-cooking/pre-cutting added ingredients (such as fruit compotes, toasted spices, or nuts).

5. Prepare the workstation by cleaning the area, gathering tools (cutting board, knives, etc.), and arranging equipment (such as a stand mixer) as required.
6. Preheat the oven.
7. Prep baking pans. (For example, the recipe may call for the baker to grease the pan, add parchment paper, or grease a liner).
8. Make a cooling station (a clear area with cooling racks, etc.).

B. ROOM TEMPERATURE: Prior to mixing, bringing all ingredients to room temperature (68°F to 70°F) is an essential step in preparing a well-mixed butter cake.
   1. *Butter:* Butter should be brought to between 60°F and 70°F, or as stated in the recipe, but it shouldn't be too soft (or melted). Butter that is too cold won't beat evenly. It won't incorporate air or increase in volume. Butter that is too soft is unable to adequately trap air, and it may cause the cake batter to collapse in the oven.
   2. *Eggs:* Cold eggs do not whip as well as room temperature or warm eggs. Cold eggs decrease cake volume and may cause a chocolate batter to seize (not blend smoothly). When eggs and liquids are cold, the batter can curdle (separate into liquid and fat), and the texture may become too dense.
   3. *Fat:* If any of the ingredients are too warm, the fat will melt and not whip effectively enough to incorporate air.

C. SIFTING: Thoroughly sifting all dry ingredients together helps produce an evenly-baked butter cake.
   1. *Lumps:* Cake flour and cocoa powder are finely ground products. They tend to form small lumps that don't break apart during blending or beating, especially when they are not sifted with the other dry ingredients.
   2. *Tunnels:* The result of unevenly sifted dry ingredients can be the creation of large holes and tunnels in the middle of the baked cake.
   3. *Raw Flour Pockets:* Using a sifter or a wire whisk helps ensure that all raw flour is evenly distributed throughout the batter (and that no pockets of batter are surrounded dry flour).

D. MIXING: ***Mixing*** is a general instructional term that describes stirring, beating, blending, binding, creaming, whipping, and folding—any action that combines two or more ingredients evenly to become one product. Each mixing method adds a different texture and character to a baked good. Even the paddle, hand-whisk, or wire-whisk attachment can make a difference in the final outcome. (The type of spoon can also affect the finished product.)
   1. *Stirring:* All ingredients are mixed together with a utensil, usually a spoon, in a circular motion.
   2. *Beating:* Ingredients are moved vigorously in a back-and-forth, up-and-down, and around-and-around motion until the components are smooth.
   3. *Blending:* Everything is thoroughly mixed until the ingredients become one product.

4. *Creaming:* Fat and sugar are beat together until they are light, airy, and pale-colored.
5. *Whipping:* Air is incorporated into the ingredients (often whole eggs, egg whites, or heavy cream) by mechanical means, such as a stand mixer, a hand mixer, or a wire whisk.
6. *Folding:* One ingredient is gently folded into another, by hand, with a large spoon or spatula. This keeps the batter light and aerated. (Whipped creams and eggs are often folded into other ingredients to maintain their airy quality.)

E. CREAMING: ***Creaming*** is the process of beating a solid, room-temperature fat (butter, shortening, margarine, lard) and dry, crystalline sugar (usually granulated sugar or brown sugar—powdered sugar is not incorporated during creaming) together rapidly to add air. Creaming is a preliminary stage for preparing butter cakes and cookies. It is one of the most important mixing methods used in making butter cakes. Creaming forms ***foam*** (suspended gas bubbles) by incorporating air bubbles into fat. As sugar is beaten with the fat, the sugar crystals cut holes in the fat, and these air pockets (bubbles) are held in the mixture. These bubbles expand during baking and help to leaven the cake.

F. CREAMING METHOD: The ***creaming method*** is the technique of vigorously mixing air into the batter, one ingredient at a time, to create a soft, light, creamy mixture. This signature texture begins with the initial creaming of fat and sugar. Bakers use the creaming method every day. It is the most-used process to create butter cakes, cookies, and other desserts. Cakes mixed by the creaming method pull away from the edges of the cake pan when done. Five basic steps for creaming will be used in most recipes.

1. *Step One, Butter:* Room temperature butter should be creamed with a stand mixer (with a paddle or a flat beater) on medium speed, or by hand (a wooden spoon mashing the butter against the side of the bowl), until it is smooth and creamy. [NOTE: Bakers achieve the most air incorporation using a stand mixer.]
2. *Step Two, Sugar:* Sugar should gradually be added to the butter (on high speed) until the mixture appears light, fluffy, and pale in color (due to the incorporation of air). The air will later help the batter expand in the oven and rise. Recipes provide guidance in the approximate amount of time to cream the mixture, and they usually describe the color sought, such as “pale yellow” or “almost white in color.” [For more details about this step, the King Arthur Flour video, “How to Cream Butter and Sugar,” can be seen at http://www.kingarthurflour.com/videos/how-to-cream-butter-and-sugar for step-by-step procedures. Then, the King Arthur Flour website blog article, “Creaming Butter and Sugar: The Right Temperature, The Right Timing, The Best Results for Your Baking,” can be seen at http://blog.kingarthurflour.com/2015/04/27/creaming-butter-sugar/.]
3. *Step Three, Flavor:* Flavoring is added. Fat disperses the flavor throughout the batter.
4. *Step Four, Eggs:* Room temperature eggs are added one at a time (or as directed) until they are incorporated. Eggs help stabilize the mixture and make

it more elastic for the air bubbles. They allow air bubbles to expand, which keeps the batter from collapsing while baking. [NOTE: The addition of too many eggs at one time can cause the emulsification in the batter to break down. This, in turn, causes the mixture to break and lose volume.]

5. *Step Five, Combine Liquid and Dry Ingredients:* Finally, the dry ingredients are added alternately with the liquid ingredients—mixed only to blend after each addition. The sides of the bowl are scraped several times (without the batter being overmixed). The additions should end with the dry ingredients—to help ensure that the batter does not break (the batter would have a curdled appearance).

G. BLENDING METHOD: The ***blending method*** (two-stage method) is a mixing technique in which dry ingredients are mixed before wet ingredients. In this method, the weight of the added sugar should be equal to, or greater than, the weight of the added flour. (High ratio cakes, such as spice, German chocolate, and carrot are examples.) Also in this method, the liquid is added in stages. [NOTE: Since the liquid is added after the butter and flour are combined, gluten formation is reduced in the flour. This is due to the fat coating all of the flour before the toughening action from the liquid takes place.] A blended cake is often heavier, with less volume (because it doesn't form as many air bubbles) than its creamed counterpart. Additionally, after baking, the cake might not pull away from the edges of the pan. While a creamed butter cake is light, but strong, a blended cake is tender, with a velvety crumb. These cakes melt in your mouth, because less gluten is formed. Temperatures and mixing speeds are very important to these batters. Following recipe directions is crucial to success with the blending method.

1. *Step One, Dry:* The dry ingredients, including the sugar, are placed together in the mixer bowl. They are sifted or whisked together to distribute the salt and leavening agents. [NOTE: Most formulas use high-ratio cake flour.]
2. *Step Two, Eggs, Flavoring, and Liquid:* In a separate bowl, the eggs get mixed with the flavoring and one-fourth of the liquid. They should be mixed well to break up the eggs. Mixing this way helps guarantee a smooth batter that doesn't separate. The egg mixture will keep lightness in the cake.
3. *Step Three, Fat and Liquid:* Softened butter and the egg mixture are stirred into the dry ingredients (on a low speed, to moisten). Then, the batter is mixed on a medium speed to develop some structure and to aerate the batter. The bowl should be scraped frequently. (TIP: The total mixing time should be under two minutes.) [NOTE: Most commercial formulas use emulsified shortenings (cake, icing, or high-ratio shortening). Emulsified shortenings are able to absorb more sugar and liquid than regular vegetable shortenings. They provide a finer and smoother texture, are more economical, and keep cakes moister than butter. They are also used for commercially-prepared icings to extend shelf life.]
4. *Step Four, Liquid:* The remaining liquid should be added slowly, in halves, being mixed a few seconds (just enough to blend) after each addition. The

sides of the bowl should be scraped frequently. This process should take about five minutes, or until it is perfectly blended.

H. PRE-MADE MIXES: Pre-made cake mixes use the blending method. Most cake mixes contain all of the dry ingredients, and the baker adds the eggs, liquid, and fat. Aside from using the cake mix as a simple butter cake, cake mixes may be enhanced. For example, Better Homes & Gardens (BH&G) has recipes to fix up store-bought cake mixes for yellow, white, or chocolate cakes. (Source: Better Homes & Gardens.) The fixes included the following:

1. Adding spices to the dry cake mix, such as cinnamon, ginger, allspice, or nutmeg. For example, adding cinnamon to a chocolate cake can create a Mexican chocolate cake.
2. Many ingredients can create a depth of flavor, including applesauce, instant coffee crystals, finely shredded orange peel, maple flavoring, or almond extract. For example, coffee crystals in a chocolate cake will make a mocha cake. Generally, these ingredients would be added with the eggs.
3. Fruit juice can be substituted for water. For example, unsweetened pineapple juice in a white or yellow cake mix can balance a cake's sweetness.
4. Once the batter is prepared, BH&G suggests stirring in any number of fruits, nuts, or vegetables before baking, such as coconut, almonds, chips, or well-drained, chopped maraschino cherries. For example, the addition of pineapple juice and shaved coconut to a yellow cake mix makes a Piña Colada Cake. [NOTE: Cake mixes can become the base for more elaborate cakes. For more information, the Mr. Food Test Kitchen webpage, "Cake Mix Recipes: 39 To-Die-For Recipes with Cake Mix," can be seen at http://www.mrfood.com/Cakes/27-To-Die-For-Recipes-with-Cake-Mix. Also, an extensive list of recipes can be browsed at the Allrecipes.com webpage, "Cake Mix Cake Recipes," at http://allrecipes.com/recipes/386/desserts/cakes/cake-mix-cakes/.]

I. CAKE-PAN SELECTION: The volume of a typical butter cake recipe is six cups of batter. However, cake pan volumes vary. To fill and bake cakes in the different pans, a baker must take note of the volume by cups and the estimated baking time. [NOTE: To determine a pan's dimensions, inside edge to inside edge is measured to ensure that the thickness of the pan is not included. The following volumes and baking times have been sourced from a few websites, including Joyofbaking.com at http://www.joyofbaking.com/PanSizes.html and (for volumes), The Spruce Eats at https://www.thespruceeats.com/cake-baking-times-per-pan-305281 (for times), and King Arthur Flour at https://www.kingarthurflour.com/ (for Bundt® cakes).]

Pan Type (in Inches)	Volume	Estimated Baking Time
Two 8 × 2 round layer	6 cups (1.4 liters)	30 to 40 minutes
Two 9 × 1½ round layer	6 cups (1.4 liters)	25 to 35 minutes
One 13 × 9 × 2 rectangular	14 cups (3.3 liters)	30 to 35 minutes
One tube (10 × 4)	16 cups (3.8 liters)	35 to 40 minutes

Pan Type (in Inches)	Volume	Estimated Baking Time
24 cupcakes (standard size)	6 cups (1.4 liters)	14 to 23 minutes
Two 8 × 8 × 2 square layer	8 cups (1.9 liters)	25 to 35 minutes
One bundt (7½ × 3)	6 cups (1.4 liters)	40 to 45 minutes
One bundt (9 × 3)	9 cups (2.1 liters)	Consult recipe/formula
One bundt (10 × 3½)	12 cups (2.8 liters)	Consult recipe/formula

1. Bundt® pans have curved sides and decorative shapes that create different capacities in each pan. For example, most cakes need a space of 1¼ inches to rise. A baker can fill a pan with water to within 1¼ inches, measure the water, and compare the measurement to the chart for a bake time.
2. If a tube pan is substituted for a Bundt® pan, the baking time is reduced. The straight-edged tube pan holds more volume, but has a shallower depth. Baked goods with shallow depths always bake faster, because the rate of chemical reactions is affected by how quickly energy is absorbed. Shallow depths absorb energy more quickly.

J. CAKE PAN PREP: Different cake pans, recipes, and batter ingredients require different pre-baking preparations.

1. *Ungreased:* Angel, chiffon, and most sponge cakes are baked in ungreased pans. During baking, the batter expands up the sides of the ungreased pan for support. Butter cake recipes made with cornstarch bake in ungreased pans.
2. *Greased:* Lard or solid vegetable shortening, such as Crisco® (not butter, margarine, or sprays), is applied to the inside of layer, Bundt®, tube, loaf, square, and rectangular cake pans. The shortening can be spread with fingers, a pastry brush, or a paper towel. Shortening tends to release cakes easier than other fats.
3. *Greased and Floured:* First, the pan is greased. Then, about one teaspoon of flour is sprinkled into the pan while it is tapped and turned (until the flour adheres to the greased bottom and sides). The pan is inverted, and the excess flour is tapped out. Recipes that use fluted tube pans usually direct the baker to grease and flour the pan. [NOTE: Cakes served from a pan would not require flouring.]
4. *Grease, Parchment Paper, and Grease:* The grease, parchment paper, and grease method is especially desirable when baking tender layer cakes. The process for a baker is as follows:
   a. Lightly grease the layer pan.
   b. Add a parchment or silicone liner.
   c. Grease the parchment or silicone liner.
   d. To remove layers from the pan, loosen any cake that clings to the sides of the pan. Turn over the pan onto a rack, a plate, or your hand. The greased parchment or silicone layer ensures that the cake layer comes out cleanly.

5. *Greased and Sugared:* The baker follows the grease and flour method, but substitutes sugar for flour. Some recipes for Bundt® cakes use this technique. The heated sugar allows the cake to more easily release from the Bundt® pan's crevices.
6. *Non-Stick Pans:* Non-stick or coated pans may have specific directions for greasing.
7. *Indent Batter:* To prevent rounded cake tops, a rubber scraper can be used to (lightly) move batter away from the middle of the cake. Since the middle of the cake rises more than the sides, this slight indentation allows the cake to rise levelly. Rounded cakes are more difficult to ice. If stacking, the middle bump must be trimmed and sealed with a thin coat of icing. To prevent crumbs in the icing, the cake should dry (cool) slightly, before being iced.

K. TESTING DONENESS: Bakers all have their own systems for knowing when a cake is done. Most home and professional chefs test creamed or blended cakes for doneness by using one of a few time-honored methods. With practice, a backer develops a sense of the additional time the cake will need.

1. *Time, Temperature, and Aroma Test:* The baker surmises doneness after the cake has been in the oven for the requisite amount of time, has baked at the suggested temperature, and "smells like cake."
2. *Toothpick Test:* A toothpick, a thin skewer, or a cake tester is carefully inserted into the center of the cake. If it comes out cleanly, the cake is done. If not, it needs more time. The cake tester should be washed and dried, or a new toothpick should be used, each time the cake is tested for doneness.
3. *Color Test:* The cake is lightly browned (golden).
4. *Touch Test:* If the cake's center is touched lightly with fingers, it springs back. If it has an indentation, it needs more time.

L. COOLING: Most cakes should be cooled before icing or serving.

1. *Simple Cakes:* Plain or simple cakes can cool in the pan for about five minutes (on a cooling rack). Then, the cakes can be removed from the pans to thoroughly cool. Leaving the cakes in the pan can continue the baking process, and it might result in a soggy or overbaked cake. Plain cakes include chocolate, yellow, and white (and most creaming-method varieties).
2. *Rich, Dense, or Multi-ingredient Cakes:* These cakes should cool in the pan for 10 to 15 minutes before removal. This method applies to German chocolate, carrot, gingerbread, and pineapple upside-down cakes (most blending-method varieties).

Teaching Strategy: *Use VM–F to review the rules for mise en place. Use VM–G to illustrate examples of butter cakes created by the creaming method. Have copies (or webpages) of creaming-method recipes or formulas available for students to review. Use VM–H to illustrate examples of butter cakes created by the blending method. Have copies (or webpages) of blending-method recipes or formulas available for the students to review. Students can evaluate each recipe using mise en place rules (see VM–F).*

Use VM–I to illustrate pan sizes for butter cakes. Lead a short discussion of students' prior experiences making and tasting butter cakes. Expand this discussion to the engineering of a cake. Brainstorm new flavors for butter cakes. Then, identify the required ingredients and the target audience. Next, determine whether the new cake flavor could be sold as an individual piece. For example, what if Little Debbie or Hostess made these cakes? Would the new individually-wrapped cake sell alongside Little Debbie? What would the packaging for the new cake look like?

Duo Demonstrations: *Demonstrate the creaming method using a bowl and the back of a wooden spoon—one demonstration is by the instructor and one is by the student. The instructor should make mistakes in the demonstration (use cold butter, add cold eggs, fail to sift dry ingredients, forget to preheat the oven, forget to prep the pans before mixing, forget to make a dip in the center of the batter before baking, over bake or under bake, etc.) The student would then demonstrate how to correctly prepare the batter (with help of the other students). [NOTE: The student would be prepared in the proper way to conduct each step and demonstrate it to the class. The demonstration should also include preparation of the pans, preheating the oven, etc.] Bake the cakes (hopefully the instructor's cake would have a rounded top rather than a flat top). Then, the remaining students would evaluate the importance of each step in butter cake preparation. As a class, construct a data table to evaluate the difference in both cakes. A possible data table is included here.*

Butter Cake Procedures: Correct and Incorrect Comparisons

Characteristics	Correct methods description	Incorrect methods description
Level top		
Ease of removing from pan		
Texture/tenderness		
Flavor		
Cake Structure		
Ease of removing from pan		
Length of baking time		
Others:		

Students should use descriptive terms to describe the correct or incorrect steps taken that resulted in the cake's characteristics.

Objective 3: Analyze physical changes and chemical reactions that occur in butter cake preparation.

Anticipated Problem: What physical changes occur during butter cake preparation? What chemical reactions occur during butter cake preparation? How does surface area affect the baking time of cakes? How does the pan size affect the baking time of cakes? How do humidity and altitude affect the baking of cakes?

III. Baking is a science. Many scientific actions occur when making and baking butter cakes. Numerous physical changes and chemical reactions are necessary to prepare the perfect butter cake. The difference between a chemical reaction and a physical change is compositional. This section will discuss the definitions and various situations relating to chemical reactions and physical changes when baking. [NOTE: Batter will be discussed throughout, but the same principles apply to doughs.]

A. CHEMICAL REACTIONS: A ***chemical reaction*** is a process that produces a permanent change in the chemical composition and molecular structure of a substance. For example, fresh eggs that are fried cannot become fresh eggs again. The protein in the egg has been permanently changed, and the structural makeup is very different. When batter is heated in an oven, a chemical reaction occurs and new bonds are formed. Heat creates exothermic and endothermic chemical reactions. For example, baking a cake produces an endothermic reaction that changes sticky batter into a solid cake. An ***exothermic reaction*** produces heat. An ***endothermic reaction*** absorbs heat.

1. Heat helps leavening agents produce tiny gas bubbles that make the cake light (by rising).
2. Heat causes egg proteins to firm, helping to give the cake structure.
3. Heat dries cake batter (fats are still able to keep the cake moist).

B. PHYSICAL CHANGES: A ***physical change*** is the transformation of a substance that does not alter its chemical properties—a phase change. The change can involve a difference in the way the substance displays appearance (color or shape), texture, temperature, or smell, but it usually results in a change of state, such as liquid to solid. Melting, boiling, and freezing are examples how to create a physical phase change. An ice cube that melts is still water, and its chemical properties remain intact. [NOTE: In the physical change described here, the ice cube and warm temperature are the reactants—the ingredients of physical change. The liquid water is the product, or result, of a physical change.]

C. ABSORPTION: ***Absorption*** is the act of one substance (liquid or solid) taking up (soaking up) particles from another substance (gas or liquid) by physical or chemical means.

1. *Hygroscopic:* ***Hygroscopic*** is a term relating to the ability of a substance to absorb water from its surroundings. Liquid is absorbed into flour. The more water absorbed into flour, the more the batter stretches. This creates more pan flow (ease of the batter filling the pan's shape). Sugars are hygroscopic, including table sugar, honey, brown sugar, and molasses. Sugar attracts water,

keeping baked goods moist and soft. [NOTE: The prefix "hygro" relates to humidity. A hygrometer measures humidity, while a hygroscope indicates when humidity is present.]

2. *Gluten:* ***Gluten*** is an elastic protein found in wheat and cereal flours that gives batter elasticity, strength, and rising ability. Gluten comes from a plant's endosperm (the starchy portion of a grain), and it forms when water is added to the two flour proteins of glutenin and gliadin (found in wheat, barley, or oats). Gluten continues to develop as the butter-cake batter (or other wheat batter) is mixed. Gluten provides chew and density.

D. CONDENSATION: ***Condensation*** is the conversion (a physical change) of a vapor (gas) into a liquid—the reverse of evaporation. When cold batter and dough are placed into a warm oven, moisture (condensation) is produced on the surfaces. This action cools down the crust, and it allows the baked good to rise before the crust hardens. A porous surface on a baked good can be due to over-condensation.

E. EVAPORATION: ***Evaporation*** is the conversion (a physical change) of a liquid into a vapor (gas). The rate of evaporation increases with the rise in temperature. Evaporation is used in many culinary processes to concentrate a solution; such as cooking down pan sauces to thicken and intensify the flavor, simmering tomatoes to release moisture, or thickening a roux.

F. EMULSION: An ***emulsion*** is a semi-liquid, stable mixture in which one or more liquids are suspended within another. An emulsion can have two or more ***immiscible*** (unmixable) ingredients. While emulsions are immiscible, ***homogeneous mixtures*** are a mix of ingredients that have a uniform composition (the same properties throughout).

1. Typical emulsions include a liquid suspended in a fat or an oil. (Think of vinegar and oil dressing.) The goal in baking is to form a water-in-fat emulsion. An unstable cake batter emulsion can curdle or weep. [NOTE: The addition a tablespoon or more of flour to a curdled cake batter may reverse the appearance of curdling. This is only necessary when batter is whisked for air leavening. Modern, self-rising flours should add enough air bubbles through their leavening process, keeping the cake light. Adding too much flour might make the cake dense and tough.]
2. Creaming is a common step in baking and pastry recipes. Typically, room temperature eggs are added one at a time in the creaming method. This slow procedure adds more air to the batter, and the egg yolks act as an emulsifier. They keep the creamed fat and liquids from separating (which makes the batter a homogenous mixture). [NOTE: For more information about emulsions in cake batters, Sarah Phillips's Craftybaking.com article, "Emulsify," can be read at https://www.craftybaking.com/howto/emulsify. For more general information about emulsions, the MYcaert CA B3–8 lesson and e-unit can be referenced.]

G. HEAT TRANSFER: A ***heat transfer*** is the exchange of thermal energy between two objects, or the physical process of a food absorbing heat from a source. While heating food, molecules absorb energy, vibrate quickly, and bounce off each

other. Each collision produces heat, which is transferred to the food. This is the basis of cooking. There are three methods of heat transfer. [NOTE: For more detailed information, the Biscuit People article, "Heat Transfer for Biscuit Baking," can be read at http://biscuitpeople.com/heat-transfer-for-biscuit-baking/. Their process described for biscuits is the same for butter cakes.]

1. *Radiation*: ***Radiation*** is the transmission of heat through waves of energy. Microwave and infrared waves are two types of radiation in cooking. Radiant heat is evident with the opening a preheated oven, a hand stretched over coals, or the feeling of skin near a boiling pot. Warmed air is transferred to food and cooks it (radiation cooks through indirect contact).
2. *Conduction*: ***Conduction*** is the passing of heat between solid objects through direct contact. For example, heat is conducted from stovetop burners to pots and pans. Heat is then conducted from the pots and pans to the food. Cake pans transfer heat, by conduction, to the batter.
3. *Convection*: ***Convection*** is the transfer of heat by the circulation of warm air or water. In a convection oven, a fan blows hot air over and around the food. (In savory cooking, sous-vide is a method of cooking sealed bags of food in a warmed water bath.)

H. OSMOSIS: ***Osmosis*** is the movement of fluid through a semipermeable cell membrane (from a less concentrated substance to a more concentrated one). A solute is the substance that dissolves into a solution (the less concentrated substance). Osmosis occurs in butter cakes, especially those that contain fruits or vegetables. [NOTE: Simple osmosis and diffusion experiments can be seen on the Kitchen Pantry Scientist website at http://kitchenpantryscientist.com/diffusion-and-osmosis-experiments/.]

1. Fruits and vegetables have semipermeable cell membranes that cause cells to release water when cut. This can cause frozen fruit and cooked fruit to wilt. Fresh fruits are crisper, and release less water.
2. When sugar is added to freshly cut fruit, the concentration of sucrose is higher around the fruit than inside the fruit cells. Sucrose is too large a molecule to move into the cells of the fruit. Osmosis occurs when the moisture from the fruit moves into the sugar, or when fruit and vegetable slices are mixed with dry ingredients, such as sugar, spices, and flour.

I. CARAMELIZATION: ***Caramelization*** is the oxidization (browning) of sugar, or the natural sugars in fruits and vegetables, in order to get a sweet, nutty, brown sauce or coating. Caramelization is the last chemical reaction to occur during baking. It only occurs when sugars are heated. The flavors of caramelization occur after 356°F is reached. Cakes baked at 350°F have no caramelized flavor, but might have sugars that caramelize. Each sugar type caramelizes at a different temperature.

1. Fructose caramelizes at 230°F (110°C).
2. Sucrose caramelizes at 320°F (160°C).
3. Baked goods made with honey or fructose develop a darker color, because they begin browning at a lower temperature (honey contains fructose).

J. HYDROLYSIS: ***Hydrolysis*** is the chemical separation of a compound through the addition of water. For example, adding water to sucrose leaves glucose and fructose. The result of this hydrolysis is an invert sugar. An ***invert sugar*** is equal parts glucose and fructose (derived from water and sucrose). The creaming method for butter cakes allows time for the hydrolysis of sugar to begin (from being mixed with fat and egg moisture). This is why the dry ingredients are added after the creaming technique is completed. Letting sugar-liquid-fat batter set 10 minutes before adding flour ensures the sucrose becomes an invert sugar. [NOTE: Inversion processes can involve the hydrolysis of sucrose with an acid and some heat (used in candy making).]

K. MAILLARD REACTION: The ***Maillard reaction*** is a chemical effect that occurs when proteins and sugars react and break down under heat. Amino acids and simple sugars rearrange into rings that reflect light and produce a browned appearance (and tantalizing aromas). It is a series of three complex reactions. These reactions occur between amino acids (proteins) and sugars (monosaccharide and some disaccharide sugars that can donate electrons to another chemical) being reduced at higher temperatures. The Maillard reaction (named for the scientist, Louis Camille Maillard) produces different aromas in bread than in standing rib roast or baked fish, because the amino acids and simple sugars differ in those foods. This process is responsible for the browning of a butter cake, as well as its toasted flavor. As the oven, grill, or pan temperatures increase, so does the Maillard reaction. [NOTE: The Food-Info.net website has for more information on complex reactions and Louis Maillard at http://www.food-info.net/uk/colour/maillard.htm.]

L. CARBON DIOXIDE: ***Carbon dioxide (CO_2)*** is a colorless, odorless gas (except in high concentrations), and it is a natural by-product of cellular respiration. Baking soda, baking powder, and yeast are all leavening agents that produce CO_2. (Baking soda and baking powder are two common chemical leavening agents, while yeast is a living organism.) CO_2 is evident in the leavening of butter cakes and other baked goods.

1. Baking soda ($NaHCO_3$), or sodium bicarbonate, is a chemical leavening agent that, when heated, produces and releases carbon dioxide using the formula $2NaHCO_3 \rightarrow CO_2 + Na_2CO_3 + H_2O$. (Sodium bicarbonate releases carbon dioxide, sodium carbonate, and water vapor.)
    a. In a recipe, Sodium bicarbonate needs paired with an acid. If baking soda is used in a recipe without an acid, it will produce a bitter taste and a yellowish color.
    b. Baking soda is a single-action (reacts only once) chemical leavening agent that reacts when mixed with an acid, such as cream of tartar, buttermilk, molasses, sour cream, yogurt, lemon juice, vinegar, brown sugar, or cocoa. [TIP: When a butter cake that uses baking soda is baked, everything must be ready before the liquid is added to the leavening agent (the section on leavening components can be referred to).]
2. Baking powder is a chemical leavening agent that contains baking soda, dry acids, and starch (as filler). It produces more carbon dioxide gas than baking

soda. When heated, it produces carbon dioxide using the formula $NaHCO_3 + H^+$(from the acid) $\rightarrow Na^+ + H_2O + CO_2$. (Sodium, water, and CO_2 are all released.)

3. Some butter cake recipes and formulas use both baking soda and baking powder.

M. HYDROGENATION: ***Hydrogenation*** is the charging or combining of a molecule with hydrogen (H) (a chemical reaction). In baking, hydrogenation helps solidify oils and fats. The benefits include the solidifying of liquid vegetable oils, the absorption of the oxygen in the oil's free fatty acids (converting them to fats that are solid at room temperature), the improvement of the keeping quality of the fats, the ability of oils to stay solid room temperature, and the resistance of fats to break down when exposed to air. Some shortening may have added animal fats, emulsifiers, colorings, and flavorings (butter).

1. ***Hydrogenated fats*** are vegetable fats (or oils) that are hardened, or turned into solids, through the hydrogenation process. They provide more volume for baked goods than butter.
   a. Solid shortenings (like Crisco®) and margarines are hydrogenated.
   b. Peanut butter can be hydrogenated, or partially hydrogenated. Natural peanut butter is usually partially hydrogenated (oil separates and comes to the top of the jar).
2. During hydrogenation, hydrogen is injected into the oil under pressure, turning the liquid oil into a solid fat. In almost all cases of turning oil into a solid fat, some of the oil remains in a state of limbo—neither liquid nor solid—called a ***trans-fatty acid (trans fat)***. This type of fat is known to have a particularly unhealthy effect on arterial and heart health. It provides no flavor, cooking, or nutritional benefits.

N. SURFACE AREA: In baking, the ***surface area*** is the part of a baked product that is directly exposed to the heat—the total uncovered exterior. The surface area of a butter cake determines its baking time. A larger pan has more surface area and, as a result, the cake will bake quicker. On the other hand, if a baker fills a smaller, deeper cake pan with the same volume of mix meant for the large pan, the batter will have a smaller surface area, take longer to bake, and, if left at same temperature, would have an undercooked center. As a general rule:

1. Two 8 × 2 round pans bake for 30 to 40 minutes.
2. One 8 × 8 × 2 square pan bakes for 25 to 30 minutes.
3. Cupcakes, with a high ratio of surface area to volume, tend to dry out quickly in the oven. They bake for 14 to 19 minutes.

O. BATTER DEPTH: Batter depth affects the baking time of all baked goods. As a general rule, Bundt® cakes have more depth than most cakes, and they bake for 40 to 45 minutes.

P. OVEN TEMPERATURE: Butter cake oven settings vary by pan type, humidity, and altitude.

1. Shiny metal pans bake at 375°F. Shiny metal reflects the heat.

2. Dark or nonstick pans bake at 350°F. Dark pans absorb the heat.
3. Glass pans traditionally bake at 25°F lower temperatures than shiny or dark pans to prevent overbaking and too much browning. Glass pans transfer heat more quickly than metal pans.
4. Mini cupcakes are baked at a 20°F lower temperature than regular cupcakes to produce a better texture. [NOTE: More information is available in the Lane Cummings article, "How to Adjust the Oven Temperature for Mini Cupcakes," on the Our Everyday Life website at https://oureverydaylife.com/how-to-adjust-the-oven-temperature-for-mini-cupcakes-12368386.html.]

Q. HIGH ALTITUDES AND HUMIDITY: Baking in high altitudes (3,500 to 6,500 feet above sea level) requires an increase in oven temperature by 10°F to 20°F. Baking cakes on a rainy day may have the same effect as a high altitude. ***Relative humidity (RH)*** is a measure of the moisture in the air. It is the percentage of actual saturation compared to the density of vapor saturation. In other words, the higher the RH percent, the more moisture is available in the surrounding air. Both a high altitude and a high RH result in a lower barometric pressure. Rainy weather is caused by a low-pressure storm system. High elevations have dry, low-pressure air. This lower barometric pressure (thin air) tends to cause cakes to over rise, and then, to deflate. Recipes can be adjusted by decreasing the amount of leavening agent and sugar. Then, liquid and protein (milk, eggs, flour) are increased to strengthen the batter.

1. To experiment with altitude and RH issues, students of baking should follow the directions below.
   a. Depending on elevation, decrease baking soda and baking powder by ⅛ to ¼ teaspoon. (At 3,000 to 5,000 feet, decrease one teaspoon of soda to ⅞ of a teaspoon. Above 5,000 feet, it would be ¾ of a teaspoon.)
   b. Increased evaporation also increases the concentration of sugar, which can weaken the structure, so decrease sugar by one to three tablespoons per cup.
   c. Increase oven temperature by 15°F to 25°F. Use the lower increase when baking delicate or chocolate cakes. Leavening and evaporation move more quickly at higher altitudes, so use a higher temperature. This will set the cake structure before it dries out.
   d. Decrease baking time by five to eight minutes per every 30 minutes (due to increase in oven temperature).
   e. Increase liquids by one to two tablespoons at 3,000 feet, and then increase by 1½ teaspoons for each additional 1,000 feet (keeps products from drying out).
   f. Increase protein in the batter (to trap gas) by adding one to three tablespoons of flour or by adding one egg white. [NOTE: Betty Crocker recommends adding a ¼ cup of all-purpose flour and increasing the water to 1½ cups (from 1¼ cups) in high altitudes. For more information about how rain affects baking, Fred Decker's article, "Does Rain Affect Baking Cakes?," can be read on eHow at http://www.ehow.com/info_12318209_rain-affect-baking-cakes.html.]

2. RH should be monitored throughout the baking process: storage, proofing (breads), baking, and cooling.

R. BLENDING METHOD: The blending method is not only quick, it also has a scientific reasoning behind it. In the blending technique, the dry ingredients are added to the mixer bowl first. Next, the fat is added and mixed. This allows the fat to coat the dry ingredients (including flour) and be absorbed. Wheat flour contains gluten, and gluten stretches and expands when moistened. This can hold the gas produced by the leavening agent. The fat coats the gluten molecules and prevents them from developing this stretchy quality. In the blended method, a baker can beat the mixture as long as necessary and still have a tender, delicate cake.

S. CORNSTARCH: Cornstarch can be combined with flour to soften the gluten and create a less chewy, more tender cake. Typically, a ¼ cup of cornstarch would be added for an 8 × 8 pan recipe.

Teaching Strategy: *Use VM–J to illustrate heat transfer. Use VM–K to illustrate fat hydrogenation. Use VM–L to illustrate the caramelization of sugar. Use VM–M to illustrate hydrolysis and invert sugar production. Use VM–N to review surface area and baking times.*

DEMONSTRATION: *Use VM–O as a model of a mix-and-bake-in-pan cake recipe—a recipe that uses cornstarch in the batter, which is poured into an unprepped pan. If time permits, demonstrate making the chocolate cake detailed in VM–O. Did the cornstarch keep the cake tender? This experience would allow students to observe how easy it is to make a cake without a mixer. Students will be going off to dormitories and apartments with limited kitchen facilities. This is an exceptionally easy cake to prepare, and it tastes great.*

NGSS and FCS CLASSROOMS: *Students benefit from learning the biological and chemical basics of food and nutrition. Culinary Arts allows real-life applications to scientific principles. Introducing the science behind the skills gives students a head start in understanding scientific terms and reactions. Science in FCS (Family and Consumer Science, Home Ec) classrooms encourages students to develop scientific reasoning skills with a fun twist. Get students prepared for Next Generation Science Standards (NGSS). Be part of the conceptual shifts in science education. NGSS states, "K–12 science education should reflect the interconnected nature of science as it is practiced and experienced in the real world." (https://www.nextgenscience.org/) FCS classes already include problem solving, teamwork, and applying real-life concepts (including physical changes and chemical reactions). Adding science concepts in FCS classes is a continuation of what is already being taught. When teaching a skill, try to explain the science behind the skill. This will develop and prepare your students, giving them both a scientific and an artistic viewpoint.*

RESEARCH LINKS: *There are multiple benefits of teaching science in FCS classrooms. For details about teaching science in FCS, try using some of the following quick links.*

- *"Cooking Class Benefits Kids in Many Ways" on the US News & World Health Report site at http://health.usnews.com/health-news/diet-fitness/diet/articles/2011/11/10/cooking-class-benefits-kids-in-many-ways*
- *"Six Reasons You Should Study Food Science" on the Institue of Food Technologists website at http://sciencemeetsfood.org/6-reasons-why-you-should-study-food-science/;*
- *"The Top 5 Reasons to Teach Nutrition Education in Your Classroom" on the Dairy Counsel of California website at http://www.healthyeating.org/Schools/Tips-Trends/Article-Viewer/Article/521/Top-5-Reasons-to-Teach-Nutrition-Education-in-Your-Classroom.aspx.*

Assign LS–A to have students prepare butter cakes and evaluate on a data table. A butter cake lab is a great way to reinforce the basic science concepts of condensation, hydrogenation, caramelization, hydrolysis, heat transfer, etc. It also is a good, hands-on demonstration of physical changes and chemical reactions. Use VM–P to illustrate which ingredients provide texture to cakes. Consider using leftover, unused cakes to talk about the science behind baking. Have the students blend or cream a filling or topping for the cakes while going over the terms learned above. A caramel glaze could be made to focus on the science of caramelization.

Review/Summary. Use the student learning objectives to summarize the lesson. Have students explain the content associated with each objective. Student responses can be used in determining which objectives need to be reviewed or taught from a different angle. If a textbook is being used, questions at the ends of chapters may also be included in the Review/Summary.

Application. Use the included visual master(s) and lab sheet(s) to apply the information presented in the lesson.

Evaluation. Evaluation should focus on student achievement of the objectives for the lesson. Various techniques can be used, such as student performance on the application activities. A sample written test is provided. If "Part One: Matching," is too difficult for students, allow fewer number of answers and consider extra credit for the additional correct answers. If objective three on the science of butter cakes was not emphasized in the instruction, remove the "Part Two: Completion" from the test. To simplify the science questions for students with spelling problems, offer the list of science terms as a word bank.

Answers to Sample Test:

Part One: Matching

1. b
2. e
3. h
4. j
5. a
6. f
7. d
8. l
9. c
10. g

Part Two: Completion

1. hygroscopic
2. chemical reaction
3. saccharide
4. fat
5. carbon dioxide (CO_2)
6. Maillard reaction
7. surface area
8. hydrogenated
9. caramelization
10. physical change
11. scaling

Part Three: True/False

1. T
2. F
3. T
4. F
5. F
6. F
7. T
8. F
9. T
10. T
11. F

Part Four: Short Answer

Answers may vary slightly from the table key. Each answer should include at least two functions (leavening and flavoring may only have one answer).

Ingredient	Functions
Flour	Body (bulk or mass), structure, texture (tender and crumbly or firm and chewy), flavor, and gluten
Fat	Flavor and richness (especially butter or lard), moisture, tenderness (shortens gluten strands), leavening (when creamed), browning, emulsification, and even distribution of added flavors (vanilla, almond, etc.)
Eggs	Leavening via egg beating, emulsification, binding agent that holds other ingredients together, structure, moisture, color, browning (egg wash), flavor, texture, thickening
Sugar	Flavor, tenderization, color (caramelizes and aids in browning), feeds yeast organisms (aids in fermentation), moisture retention (sweetened baked goods stay moist longer than unsweetened types), batter spreadability
Salt	Flavor (heightens the flavor of other ingredients, balances sugar), slows yeast fermentation (keeping air bubbles small and uniform in size), toughens the texture of soft fat-and-sugar mixtures, and strengthens gluten protein (better texture)
Leavening	rising ability and added flavor
Liquid	Moisture, flavor, color, (browning), steam leavening, hydration (protein, starch, leavening agent), activates yeast organisms, mixes with flour for proper gluten development, binding agent (especially in quick breads and muffins)
Flavoring	Enhances or fundamentally changes the taste of baked goods

Sample Test

Name _____

Butter Cakes

Part One: Matching

Instructions: Match the term with the correct definition.

a. all-purpose flour
b. blending method
c. butter cake
d. cake flour
e. creaming
f. creaming method
g. formula
h. mise en place
i. recipe
j. shorten

_____1. A mixing technique in which dry ingredients are mixed before wet ingredients

_____2. The process of beating a solid, room-temperature fat and dry, crystalline sugar together rapidly to add air

_____3. A French cooking term that means “to set up” or “to arrange”

_____4. Tenderize

_____5. A blend of hard and soft wheat that can be bleached or unbleached

_____6. The technique of vigorously mixing air into the batter, one ingredient at a time, to create a soft, light, creamy mixture

_____7. A finely-ground, soft wheat flour with a high starch content

_____8. The written measurement of ingredients by volume, such as teaspoons, tablespoons, cups, dashes, and pinches

_____9. A rich, tender, moist, and dense baked good that has a high level of butter (or other fat) in its make-up

____10. The written measurement of ingredients by weight (in pounds, ounces, kilograms, or milligrams)

Part Two: Completion

Instructions: Provide the word or words to complete the following statements.

1. The ability of a chemical to absorb water from its surroundings is _____.
2. A process that produces a permanent change in the chemical composition and molecular structure of a substance is a/an _____.
3. The scientific name for sugar is an organic compound called _____.
4. The substance found in animal and vegetable tissue used to make butter or shortening is _____.
5. The gas produced by baking soda and baking powder is _____.
6. A chemical effect that occurs when proteins and sugars react and break down under heat (producing a browned appearance and tantalizing aromas) is the _____.
7. The total exterior space of a batter exposed to heat during baking is its _____.
8. The fats that provide more volume for baked goods than butter are _____ fats.
9. The oxidization (browning) of sugar, or the natural sugars in fruits and vegetables, in order to get a sweet, nutty, brown sauce or coating is called _____.
10. The transformation of a substance that does not alter its chemical properties is a/an _____.
11. The baker's term for weighing out ingredients is _____.

Part Three: True/False

Instructions: Write T for true or F for false.

_____1. Allowing butter cakes to cool in the pan continues the baking process and produces a soggy cake.
_____2. To test butter cakes for doneness, insert a thermometer into the center of the cake.
_____3. When baking a butter cake of shallow depth, the batter absorbs energy more quickly.
_____4. A typical butter cake recipe fills two 8 × 2 or 9 × 1½ pans, one 13 × 9 × 2 pan, or one 10 × 4 tube pan.
_____5. Cake mixes use the creaming method to prepare the batter.
_____6. The butter and eggs used to make a butter cake should remain in the refrigerator until it's time to mix them into the batter.

_____7. Shortening gets its name from its ability to shorten gluten strands.

_____8. Moisture in the batter converts to steam, which stops the leavening agents in a butter cake.

_____9. Butter cake oven settings vary by pan type, humidity, and altitude.

____10. Cornstarch can be combined with flour to produce a more tender baked good by softening the gluten found in the flour.

____11. The four main ingredients in all butter cakes are: fat (usually butter), sugar, eggs, and milk.

Part Four: Short Answer

Instructions: Answer the following.

List the functions of the basic baking ingredients in the table. [HINT: Nearly all ingredients have more than one function.]

Ingredient	Functions
Flour	
Fat	
Eggs	
Sugar	
Salt	
Leavening	
Liquid	
Flavoring	

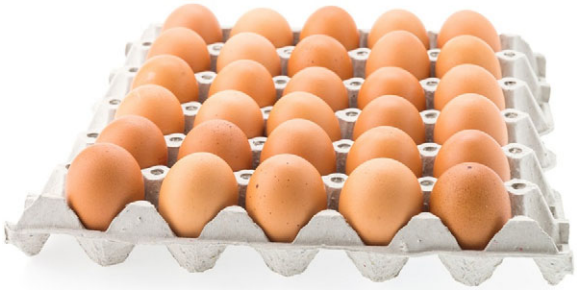
BUTTER CAKES INTRODUCTION: CAKE IDIOMS

Who in history said, “Let them eat cake?” Regardless, the phrase is still used today. What does it mean? We’ve all heard the following cake idioms. Describe what you think these sayings mean.

- “It’s a piece of cake.”
- “That takes the cake.”
- “It’s the icing on the cake.”

BUTTER CAKE INGREDIENTS: THE BIG FOUR

Butter cake (shortened cake) is a rich, tender, moist, and dense baked good that has a high level of butter (or other fat) in its make-up. The four main ingredients in all butter cakes are butter, sugar, eggs, and flour. Of the five sugars pictured here, which ones are most used in butter cakes? What distinguishes all-purpose flour from cake flour?



BUTTER CAKE INGREDIENTS: OTHERS INGREDIENTS

Other butter cake ingredients can include leavening agents (usually baking soda and/or baking powder), sour milk, buttermilk, flavoring extracts, or salt (to enhance flavors).

BASIC BAKING INGREDIENT FUNCTIONS

Due to the limited number of ingredients in butter cakes, the best results are achieved using high-quality butter, adding pure flavoring extracts, measuring and weighing accurately, and closely following formula instructions. The following table demonstrates the function of each ingredient.

Ingredient	Functions
Flour	Body (bulk or mass), structure, texture (tender and crumbly or firm and chewy), flavor, and gluten
Fat	Flavor and richness (especially butter or lard), moisture, tenderness (shortens gluten strands), leavening (when creamed), browning, emulsification, and even distribution of added flavors (vanilla, almond, etc.)
Eggs	Leavening via egg beating, emulsification, binding agent that holds other ingredients together, structure, moisture, color, browning (egg wash), flavor, texture, thickening
Sugar	Flavor, tenderization, color (caramelizes and aids in browning), feeds yeast organisms (aids in fermentation), moisture retention (sweetened baked goods stay moist longer than unsweetened types), batter spreadability
Salt	Flavor (heightens the flavor of other ingredients, balances sugar), slows yeast fermentation (keeping air bubbles small and uniform in size), toughens the texture of soft fat-and-sugar mixtures, and strengthens gluten protein (better texture)
Leavening	Rising abilitiy and added flavor
Liquid	Moisture, flavor, color (browning), steam leavening, hydration (protein, starch, leavening agent), activates yeast organisms, mixes with flour for proper gluten development, binding agent (especially in quick breads and muffins)
Flavoring	Enhances or fundamentally changes the taste of baked goods

BUTTER CAKE PREPARATION: EQUIPMENT & TOOLS

These are the equipment and tools used to make butter cakes. Can you identify them?

MISE EN PLACE

Mise en place is a French cooking term that means "to set up" or "to arrange." The baker should:

1. Read the entire recipe.
2. Collect all of the ingredients and allow them to come to room temperature (with the exception of heavy cream, which should usually remain refrigerated until use).
3. Measure all ingredients accurately, preferably by weighing.

4. Follow processes requested by the recipe. This might include chilling a stainless steel bowl in the freezer (to whip heavy cream), ensuring ingredients are at room temperature, or pre-cooking/pre-cutting added ingredients (such as fruit compotes, toasted spices, or nuts).

5. Prepare the workstation by cleaning the area, gathering tools (cutting board, knives, etc.), and arranging equipment (such as a stand mixer) as required.

6. Preheat the oven.

7. Prep baking pans. (For example, the recipe may call for the baker to grease the pan, add parchment paper, or grease a liner).

8. Make a cooling station (a clear area with cooling racks, etc.)

ASSIGNMENT: In pairs or small teams, select a recipe. List your mise en place steps. Remember to discuss required ingredients, equipment, prep tasks, and any additional processes required by the recipe.

THE CREAMING METHOD

The **creaming method** is the technique of vigorously mixing air into the batter, one ingredient at a time, to create a soft, light, creamy mixture. This signature texture begins with the initial creaming of fat and sugar. Bakers use the creaming method every day. It is the most-used process to create butter cakes, cookies, and other desserts. Name each of these butter cake types.

THE BLENDING METHOD

The **blending method** (two-stage method) is a mixing technique in which dry ingredients are mixed before wet ingredients. In this method, the weight of the added sugar should be equal to, or greater than, the weight of added flour. (High ratio cakes, such as spice, German chocolate, and carrot are examples.) Also in this method, the liquid is added stages. A blended cake is often heavier, with less volume (because it doesn't form as many air bubbles), than its creamed counterpart. While a creamed butter cake is light, but strong, a blended cake is tender, with a velvety crumb. These cakes melt in your mouth, because less gluten is formed. The melt-in-your-mouth cakes shown here are carrot, pumpkin spice (Bundt®), German chocolate, and gingerbread. Which is which?

BAKING BUTTER CAKES: PAN SIZES

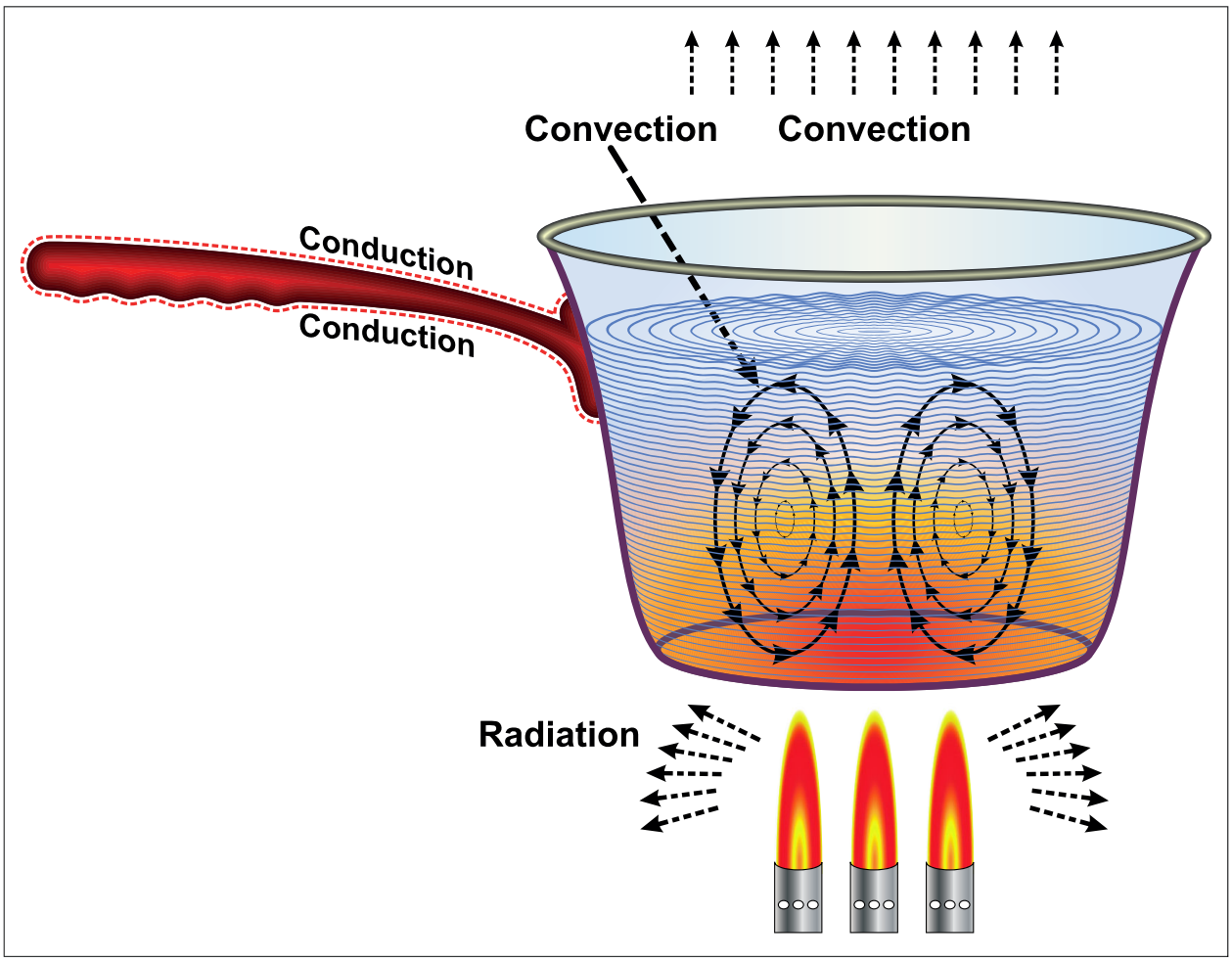
The volume of a typical butter cake recipe is six cups of batter. However, cake pan volumes vary. To fill and bake cakes in the different pans, a baker must take note of the volume by cups and the estimated baking time. [NOTE: To determine a pan's dimensions, inside edge to inside edge is measured to ensure that the thickness of the pan is not included.]

Pan Type (in Inches)	Volume	Estimated Baking Time
Two 8 × 2 round layer	6 cups (1.4 liters)	30 to 40 minutes
Two 9 × 1½ round layer	6 cups (1.4 liters)	25 to 35 minutes
One 13 × 9 × 2 rectangular	14 cups (3.3 liters)	30 to 35 minutes
One tube (10 × 4)	16 cups (3.8 liters)	35 to 40 minutes
24 cupcakes (standard size)	6 cups (1.4 liters)	14 to 23 minutes
Two 8 × 8 × 2 square layer	8 cups (1.9 liters)	25 to 35 minutes
One bundt (7½ × 3)	6 cups (1.4 liters)	40 to 45 minutes
One bundt (9 × 3)	9 cups (2.1 liters)	Consult recipe/formula
One bundt (10 × 3½)	12 cups (2.8 liters)	Consult recipe/formula

*__Note:__ The volumes and baking times have been sourced from a few websites, including Joyofbaking.com at http://www.joyofbaking.com/PanSizes.html and (for volumes), The Spruce Eats at https://www.thespruceeats.com/cake-baking-times-per-pan-305281 (for times), and King Arthur Flour at https://www.kingarthurflour.com/ (for Bundt® cakes).

PHYSICAL CHANGE: HEAT TRANSFER

A **heat transfer** is the exchange of thermal energy between two objects, or the physical process of a food absorbing heat from a source. While heating food, molecules absorb energy, vibrate quickly, and bounce off each other. Each collision produces heat, which is transferred to the food. This is the basis of cooking. There are three methods of heat transfer: radiation, conduction, and convection.



CHEMICAL REACTION: HYDROGENATION

Hydrogenation is the charging or combining of a molecule with hydrogen (H) (a chemical reaction). In baking, hydrogenation helps solidify oils and fats. The benefits include the solidifying of liquid vegetable oils, the absorption of the oxygen in the oil's free fatty acids (converting them to fats that are solid at room temperature), the improvement of the keeping quality of the fats, the ability of oils to stay solid room temperature, and the resistance of fats to break down when exposed to air.

CHEMICAL REACTION: CARAMELIZATION

Caramelization is the oxidization (browning) of sugar, or the natural sugars in fruits and vegetables, in order to get a sweet, nutty, brown sauce or coating. Caramelization is the last chemical reaction to occur during baking. It only occurs when sugars are heated. The flavors of caramelization occur after 356°F is reached. Cakes baked at 350°F have no caramelized flavor, but might have ingredients that caramelize. Each sugar type caramelizes at a different temperature.

CHEMICAL REACTION: HYDROLYSIS AND INVERT SUGAR

Hydrolysis is the chemical separation of a compound through the addition of water. For example, adding water to sucrose leaves glucose and fructose. The result of this hydrolysis is an invert sugar. An **invert sugar** is equal parts glucose and fructose (derived from water and sucrose). The creaming method for butter cakes allows time for the hydrolysis of sugar to begin (from being mixed with fat and egg moisture). This is why the dry ingredients are added after the creaming technique is completed. In these photos, notice the difference between the individual ingredients in the stand mixer and those creamed.

SURFACE AREA

In baking, the **surface area** is the part of a baked product that is directly exposed to the heat—the total uncovered exterior. The surface area of a butter cake determines its baking time. A larger pan has more surface area and, as a result, the cake will bake quicker. On the other hand, if a baker fills a smaller, deeper cake pan with the same volume of mix meant for the large pan, the batter will have a smaller surface area, take longer to bake, and, if left at same temperature, would have an undercooked center. Compare these two photos. Which one has the most surface area? Which one will bake longer? Why?

MIX-AND-BAKE-IN-A-PAN CHOCOLATE CAKE RECIPE

Chocolate Cake—Mix and bake in an 8 × 8 or a pan with a similar volume.

Preheat oven to 350°F.

Dry Ingredients:	Instructions:
2 c. all-purpose flour 2 1/4 c. sugar 1 c. unsweetened cocoa powder 2 tsp. baking soda 1 tsp. salt 1 bag milk-chocolate chips 1 3/4 c. or 12 oz semisweet chocolate chips	Place dry ingredients (except chocolate chips) in an 8 × 8 pan and mix with a fork.

Liquid Ingredients:	Instructions:
3/4 cups of vegetable oil 2 tablespoons distilled white vinegar 1 tablespoon vanilla extract 2 cups lukewarm water	Make 3 wells in the dry mix. Add each ingredient to one well—oil, vinegar, vanilla. Pour lukewarm water over entire mix, then stir well, scraping sides, until blended.

Bake at 350°F for 30 to 35 minutes (or until a toothpick inserted in its center comes out clean). Spread chocolate chips over the hot cake. Cool (in the pan) on a rack. Frost and serve.

[NOTE: For a Mexican Chocolate Cake, add a ½ to 1 teaspoon of cinnamon.]

(Source: Woman's Day, "Mix-In-the-Pan Chocolate Cake," at https://www.womansday.com/food-recipes/food-drinks/recipes/a11781/mix-in-the-pan-chocolate-cake-121221/.)

WHICH INGREDIENTS AFFECT CAKE TEXTURE?

Describe what you observe about this chocolate cake texture. Do you remember which ingredients affect cake texture?

Ingredient	Function Related to Texture
Flour	Binds, provides structure and framework
Fat (in general)	Tenderizes
Fat: Shortening	Adds more air for a cake-like texture
Fat: Oil	Creates a dense texture
Eggs	Binds, provides structure and framework
Leavening agent	Makes cake rise

LS–A

Name _____

Butter Cake Preparation and Evaluation

Purpose

The purpose of this lab activity is to prepare and evaluate two butter cakes using two different mixing methods.

Objective

While utilizing mise en place and a planning sheet, prepare, evaluate, and summarize two butter cakes made with different mixing methods.

Materials

- lab sheet
- a device with internet and printing capabilities
- two cake recipes
- ingredients for selected recipes
- equipment for selected recipes (such as two 8 × 8 pans or one 13 × 9 pan)
- hand tools (such as a whisk, wooden spoon, or rubber spatula)

Procedure

Day One:

1. **CAKE SELECTION:** Divide into lab groups consisting of two to four students each. Each lab group will partner with another lab group (such as Lab Group A and Lab Group B). Both groups decide which flavor they will compare (for example, vanilla, yellow, chocolate, or spice) [NOTE: Recipes must conform to baking two 8 × 8 layer cakes or one 13 × 9 rectangular cake.]

   a. Lab Group A: Review and select a creaming method butter cake recipe of the predetermined flavor. Receive your instructor's approval.

b. Lab Group B: Review and select a blending method butter cake recipe of the predetermined flavor. Receive your instructor's approval.
c. Both Groups: At the appropriate time, evaluate both mixing methods with your partner group using a data table found below.

2. **FOOD LAB PLAN WORKSHEET:** Individually complete (or create) an approved food-lab planning worksheet. Complete to the standards set by your school. Using a copy of the recipe:

   a. Prepare an ingredient list with amounts required to make the cake your group has selected.
   b. Make a materials list, including equipment, tools, and supplies required.
   c. Review the recipe procedures. Set up your mise en place plan.
   d. Submit the lab sheet, recipe, ingredient list, and materials list to your instructor as directed.

Day Two:

3. **CAKE PREPARATION:** Conduct mise en place. Be ready before you mix the cake batter.

   a. Prepare the cakes as directed. Each group bakes their cake either in two 8 × 8-inch layer pans or one 13 × 9 cake pan.
   b. Cool the cake as directed.
   c. Remove from pan as directed.
   d. Dust cake top with powdered sugar.

4. **EVALUATE CAKES:** Ensure both cakes (creaming method and blending method) are the same temperature when evaluated. Individually evaluate your groups' two cakes. Use the following assessment standards. Examples of comments for each characteristic are listed. Record points on your data table. Write a short summary of your data table scores and comments. Some comment examples are listed below.

   a. Exterior and Shape: Cake volume doubled during baking. The top is slightly rounded.
   b. Crust: Surface is brown, dull, a bit dry. The crumb is tender and moist.
   c. Cell Structure: Air pockets are small and evenly distributed, no tunnels
   d. Texture and Tenderness: The cake is moist, delicate, and tender. It has an easy bite and chew.
   e. Flavor: The cake is sweet with a mild hint of the added flavor.
   f. Aroma: It smells sweet, and I can detect the added flavor or ingredients (such as chocolate, apple, vanilla, or cinnamon).

Butter Cake Data Table: CREAMING METHOD

Cake Name:	**Rating Scale:** 1 = Poor to 4 = Excellent	**Lab Group _____ Names:**
Exterior & Shape	_____ of 4 points	Comments:
Crust	_____ of 4 points	Comments:
Cell Structure	_____ of 4 points	Comments:
Texture/Tenderness/Crumb	_____ of 4 points	Comments:
Flavor	_____ of 4 points	Comments:
Aroma	_____ of 4 points	Comments:
TOTAL:	_____ of 24 points	

Data Summary:

Butter Cake Data Table: BLENDING METHOD

Cake Name:	Points	Lab Group _____ Names:
Exterior & Shape	_____ of 4 points	Comments:
Crust	_____ of 4 points	Comments:
Cell Structure	_____ of 4 points	Comments:
Texture/Tenderness/Crumb	_____ of 4 points	Comments:
Flavor	_____ of 4 points	Comments:
Aroma	_____ of 4 points	Comments:
TOTAL:	_____ of 24 points	

Data Summary:

5. **WRITTEN STATEMENT:** With your lab partners (Lab Group A and Lab Group B), write a compare and contrast statement of each tested cake. (Use the data summaries for each product as a basis for this written statement.)

6. **DEBRIEF EVALUATION:** Participate in a class debrief of data summaries. Read your written statement to the class and discuss the difference that the mixing methods made.

7. **OPTION:** Repeat the assignment using a different mixing method for your same cake. Compare your two cakes side by side. What are the differences? Discuss them during the debrief evaluation.

8. Turn in your data tables, data summary, lab sheet (and a piece of cake!) to your instructor as directed.

Butter Cake Preparation and Evaluation

1. You can have the students create a planning worksheet or provide one. A Food Lab Planning Worksheet example is at http://www2.informns.k12.mn.us/schoolties/files/2741430/01495/bjohnson2/1141420Food%20Lab%20Planning%20Worksheet.pdf.
2. A bank of specific butter cake recipes using the creaming and blending methods could be provided. This will speed up the planning process and help with lab budgets. Otherwise, have students find them online (suggest Rose Levy Beranbaum's website) or in approved cookbooks. (Or, try classics, like "The Joy of Cooking," or "Baking with Julia." It could also be fun to use Americana recipes from early Better Homes and Gardens or Betty Crocker cookbooks.)
3. The data tables for this lab activity are shown above. For ease, the data tables could be printed as two-sided, one sheet for each student.
4. OPTIONS: Instead of using the 13 × 9-inch rectangular pan and baking a full size butter cake recipe, the batter could be divided into two pans (two square or round layer pans). One layer could be used for the samples in this activity and to complete the data table. The other layer could be frozen and used in the lab activities in MYcaert lesson CA C8–6 Frosting, Icing, and Glaze.