❖ Ingredient Function

➢ ***Flour***: flour provides bulk/mass. When wet, two proteins present in wheat flour, glutenin and gliadin, form gluten, a stretchy protein structure that adds strength to your baked goods. Manipulating the amount of gluten formed by a)using higher or lower protein flours and/or b)using mixing methods designed to promote/impede gluten development is vital to ensuring that your baked goods have the texture you desire. Flour also contains lots of starches. When starches get wet with water-type liquids (as opposed to oil), they start to swell up or gelatinize. Starch gelatinization is one of the main source of structure for anything you bake. Flour refers to any type of finely ground, powdery grain. As long as we're not talking about gluten-free baking, flour refers to wheat flour. Two basic types of wheat:

- hard wheat--comprised of three main types:
  - hard red winter wheat
  - hard red spring wheat
  - hard white wheat

  All three types contain relatively-to-very high amounts of protein, and lots of protein means lots of gluten. And lots of gluten means lots of chewiness. And that means that hard wheat flours are all best used for *bread baking*.

- soft wheat--comprised of two main types:
  - soft white wheat
  - soft red winter wheat

  Both types of flour contain relatively small amounts of protein. Less protein means less gluten, and less gluten means more tenderness. Less structure, but less chew. These flours are best used for *cake* and *pastry* flour.

So what about all purpose flour? All purpose, or AP, flour is a *mixture* of flours made from hard and soft wheat. They generally contain enough protein to make a nice sandwich bread (not too chewy), but not so much protein that you can't make a tender cake.

- ***Sugar***: Sugar adds sweetness and flavor, sure. But it also weakens gluten which leads to a tender product. It also browns well. Sugar is hygroscopic, which means that it draws moisture to it. That's why the sugar bowl gets lumpy on humid days. Since sugar draws moisture (or water) to it, it helps to keep baked goods moist. Sugar is important in the creaming method especially because the sugar crystals are what creates all the little holes in the butter, and the holes are what fill with gases that expand, giving us rise.

  In baking, sugar generally refers to white, refined sugar, but many other sweeteners can be used as well. You can even use liquid sweeteners, but you will have to reduce the amount of liquid called for in the recipe to keep your batter from being too wet. Other sweeteners you can consider are:
  - light brown sugar
  - dark brown sugar
  - demerara or turbinado sugar
  - powdered sugar
  - honey
  - maple syrup
  - molasses
  - corn syrup
  - malt syrup
- ***Fat***: Fats are called "shortenings" for a good reason. They actually act to physically shorten strands of gluten. And the shorter the gluten strands, the more tender your baked good. That's why angel food cake, which contains zero fat, seems pretty chewy. Even though you make it with low

protein flour (cake flour), there's no fat around to tenderize it. And that's why there's so much sugar in it. Since sugar tenderizes too, some of that sugar is kind of standing in for the missing fat. Fats also add moisture (or at least a moist feel in your mouth since they don't really contain water) and richness. Add a bit of fat to a bread recipe to make it last longer--fats help keep foods from staling quite so quickly. Fat is a great carrier of flavor (a fatty steak generally tastes "steakier" than a really lean steak, and buttered toast tastes way better than dry toast). Fat also works with sugar (especially in the creaming method) to act as part of the leavening in a recipe. Since fats don't like to mix water, the best you can hope for is to force the fat into tiny particles through mixing. That's where the emulsifiers in eggs can help to keep the fat suspended in the batter.

Types of fats typically used in baking:

- *butter*--contains a certain percentage of water (usually about 18%, give or take). The rest is composed of milk solids and butterfat. You can buy it salted or unsalted. Salted butter generally keeps longer in the refrigerator, but unsalted is usually the standard in the bakeshop. This is so the baker can decide how much (or little) salt he/she wants to add to the recipe. If a cake is to be kept at room temperature, butter is preferable to shortening because butter melts in your mouth, and that makes the cake seem to melt in your mouth. Shortening doesn't melt in the mouth, so that's why you can get that weird, tasteless, fatty coating in your mouth after you eat cake or cake and icing that uses shortening. If you're going to refrigerate your cake, shortening is best since it doesn't get hard at colder temperatures. Butter also tastes amazing and is a natural product. For almost all cakes and cookies containing butter, it should be at cool room temperature. You want it cool enough that it isn't greasy and melty and warm enough that it is pliable. Think about

how you have to chew bubble gum to soften it up enough to blow a bubble. If you chew bubblegum that has been sitting in the car in the summertime, it's too hot and you can't blow a bubble at all. The gum is too gooey and won't hold the air you try to blow into it. Same is true for butter. It needs to be able to have a bunch of little holes cut into it by the sugar crystals, and it also has to be warm enough to expand in the oven (before it finally melts).

- *vegetable shortening*--basically tasteless with a high melting point, shortening gets very fluffy when creamed with sugar. This will ensure a higher rise than with butter, but I think that a lot is sacrificed in the way of flavor. I'd rather have a shorter butter cake than a taller shortening-based cake. Shortening is also not a natural product. It is made by hydrogenating liquid fats (animal or vegetable) which turns the liquids into solids.
- *Margarine*--margarine starts out as vegetable (or animal) shortening and then gets colors and flavors added to it. Margarine, like shortening, creams well and costs less than butter. But, again, it's not a natural product, and I don't use it. It is used a lot in commercial baking operations, though.
- *Oils*--liquid fats. Most that are used in baking have fairly neutral flavors ("Crisco" vegetable oil, corn oil, Canola oil, etc), but sometimes assertively flavored oils are used (fruity extra virgin olive oil, nut oils such as walnut or sesame oil). The main thing you might use oil for in baking is in a chiffon cake.

➢ ***Eggs***: Eggs are pretty magical. The yolks are mainly comprised of fat with a little protein and very little water while the whites are comprised almost entirely of proteins dissolved in water and no fat. Relative to most other baking ingredients, eggs are pretty expensive. And since they cost a fair

amount compared to flour and sugar, bakers really need to know how to get them to do what they want them to so they can minimize waste.

Again, as with the liquids, make sure your eggs aren't at refrigerator temperature or they will end up chilling the butter, too. And that will inhibit your rise.

Most of us think about whole eggs, but you can also get frozen and dried eggs. Eggs are very important, and they have many functions in baking:

- The proteins in the egg add to the structure of your baked goods.
- The yolks contain lecithin, which is an emulsifier. And emulsifier helps hold the water and fat parts of a batter together which leads to a final product that is consistent in crumb and texture.
- Eggs aid in browning (proteins)
- Eggs add a lovely pale yellow color to baked goods. And, since we "eat with our eyes first," this is visually appealing. (I find yellow cake much more appealing than white cake).
- The fat in yolks acts as a shortening which can tenderize gluten. Especially if there isn't much other fat in your recipe, adding an extra yolk or two can lead to a more tender final product.
- Whipping the whites, the yolks, or whole eggs to a stable foam is one form of leavening. If you have ever seen a recipe that tells you to separate the yolks from the whites, whip the whites and fold them in at the end of mixing, it's because the whites will help the cake (or whatever) to rise.

Since eggs have two distinct parts (not including the shell, which we generally like to leave out of baked goods!), you can use the whole egg, just the yolks or just the whites. Each of the three choices will yield different results.

- Using whole eggs delivers a nice balance among flavor from the yolks, protein structure from the whites and tenderizing/emulsifying from the yolks.
- Using just whites leads to a good rise (whipped whites) but, without the fat in the yolks, the resulting cake could be quite dry.
- Using just yolks makes for a very yellow, rich, tender end product with not a lot of structure (from whites). If you ever do want to make an all-yolk cake, I'd consider using bread flour rather than all purpose or cake flour.

➢ ***Liquid***: For our purposes today, we'll be talking about milk and other dairy products, but liquid could also include coffee, water, or fruit juices--even coconut water. For baking, as with fats and eggs, you want your liquid to be at cool room temperature as well. You already know how important it is that butter be at about 68F, so why chill it back down by adding refrigerator temperature water or milk?

Liquids allow all your ingredients to mix together. Gluten does not form without the presence of a water-type liquid, so without liquid, your baked goods would be nothing but a pile of dry ingredients. Liquids also absorbed by the tiny flour particles, the first step for starches to gelatinize. Incidentally, another reason to have your liquid at room temperature rather than hot (never add, say hot coffee, to your batter) is that when hot water hits flour granules, it immediately gelatinizes the outside of the flour before penetrating the entire granule. This leads to lumps in gravy, and it also leads to lumps in your cakes.

Liquid also assists in leavening, in the form of steam. Generally speaking, a wetter dough rises higher than a drier dough. Wetter dough=more water=more steam for leavening.

Most of the milk used in baking (and almost all of what you'll find in the store) is Pasteurized (heat treated to kill harmful bacteria) and homogenized (the fat particles are broken down into such small particles that they will never separated out and rise to the top as cream). Other than that, the different dairy liquids that we use differ in the amount of butterfat they contain as well as acidity:

- *whipping cream*--contains at least 30% and up to 40% butterfat. The higher the butterfat, the more readily it will whip. Also, increased butterfat means more richness and more tenderness (remember what fats do to a recipe). Neutral pH
- *half and half*--a mixture of half whipping cream and half whole milk, the fat content is between 10-12%. Neutral pH
- *whole milk*--contains 3.25% butterfat. Neutral pH
- 2% and skim milk (containing no fat) are generally not used in bakeries unless you are looking for a lower-fat product. Neutral pH
- evaporated milk--milk that has had a good portion (about 60%) of its water cooked away, leaving a more concentrated product that is kind of beige in color. Neutral pH
- condensed milk--has sugar added (so you have to subtract some sugar from your recipe) and has been cooked down by 60%. Sweetened condensed milk (SCM) is very thick and sticky. Neutral pH
- buttermilk--what used to be the whey leftover from churning butter. That isn't the case anymore. Nowadays, buttermilk is usually lowfat milk that has a bacterial culture added to it that causes it to have a tangy, sour flavor. Low pH (acidic)
- sour cream--contains about 18% butterfat and is made by culturing cream with lactic acid bacteria. It is thick and tangy. (I love it). Low pH (acidic)

- yogurt--is also a cultured milk product. It is generally pourable and tangy and helps to tenderize baked goods. Low pH (acidic)

➢ ***Leaveners***--what cause baked goods to rise. They can be either mechanical, chemical or biological in nature.

- Two types of mechanical leavening:
  - *Steam*--When water boils in a lidded pot, the steam can raise the lid of the pot. Water that is trapped in a batter or dough also turns to steam. The steam pushes against the other elements of the batter (the lid on the pot), causing it to rise.
  - *Eggs*--When you whip eggs (whole, yolks or whites), they can expand several times their original volume. What is happening here is that the proteins in the egg unravel as you whisk them (or your mixer whisks them). Once they unravel, they start to join up with each other, creating a protein network that is capable of holding a lot of air. And, in the oven, the air expands, causing rise. Most European cakes are leavened with eggs. In the US, angel food cake is primarily leavened this way, as well.
- Chemical leaveners rely on a chemical reaction between the leavener and water and/or heat. Most American-style cakes are leavened chemically.
  - *Baking soda* has a relatively high pH (it is alkaline). When it gets together with an acid (with a relatively low pH), such as vinegar, coffee, lemon juice or buttermilk in a recipe, the alkaline baking soda reacts with the acidic ingredient and releases a bunch of carbon dioxide bubbles. These bubbles get trapped in the batter (in air pockets) and expand in the hot oven, causing the batter to rise. The reaction in baking soda happens immediately, so once you mix the batter, you need to get it into the oven as quickly as possible so all your gases don't escape.

- *Baking powder* is a mixture of baking soda (alkaline) with an acid (usually cream of tartar). This makes the pH of baking powder pretty neutral, or balanced. Since the acid is in dry form, all that is needed is the addition of water for the chemical reaction to take place. You don't need buttermilk or lemon juice if the recipe calls for baking powder. There are two types of baking powder, single acting and double acting. Most modern baking powders are double acting. They release bubbles as soon as they get wet (the first action) and then again when they are heated in the oven. This is the second action of double action baking powder. This buys you a little more time since, even if you lose some gases while your batter sits on the counter, more gases will form once the batter starts to heat up in the oven. Still, it's best to get the pan in the oven as soon as possible for optimal rise.

▪ Biological leaveners: this is yeast. Yeast are little one-celled organisms that eat sugar, converting it into alcohol and carbon dioxide. In baking, the alcohol (present in very small quantities anyway) bakes off, and the carbon dioxide is trapped in the stretchy gluten strands of bread dough. This is what causes breads to rise. Yeast can be purchased fresh in cakes or dried. Dried yeast usually should be rehydrated before using, although it is possible to add it straight to your recipe. There are a few older-style European cakes, such as baba au rhum and savarin, that are leavened with yeast. They are basically sweet yeast breads that are then soaked with some sort of syrup for moistness.

➢ ***Salt***: Salt is present in very small amounts in baking, but it is vital to success. In large quantities, salt acts as a preservative, but in the quantities used in baking, it is mainly there to add flavor. I add at least a pinch of salt to everything I make. And I mean everything, from ice cream to cakes, from my coffee to vanilla pudding. Salt acts as a flavor enhancer. It doesn't

make foods taste salty; it makes them taste more like themselves. Salt also impedes yeast development (enough salt will kill yeast cells), so in bread baking, the salt keeps the yeast in check so it doesn't rise too much and then collapse. In most of my baking, I use approximately 1/4 teaspoon of salt per cup (measured at 4-4.5 ounces) of flour.

- ***The Importance of Mise en Place***: Mise en place literally means "to put in place" in French. That means that everything that you need to make your recipe should be out and completely ready to go.
  - Get out all your ingredients early enough so that they come to room temperature before starting. (See section on ingredient function)
  - Get out your cleaning supplies--you need a clean sponge or some paper towels to wipe up spills. Cleaning as you go is Way easier than cleaning at the end. Take it from me; I know.
  - Make sure all your equipment is ready: scale, measuring spoons/cups, if using, liquid measure (again, if using), spatulas, wooden spoons, cake pans, cooling racks--whatever you need, hardware-wise, to bake your cake.
  - Measure all ingredients and then put the containers away.
    - While most home cooks use volume measures (cups and half cups, tablespoons and teaspoons, etc), it is most accurate and absolutely preferable to weigh ingredients. You know the old trick question, "What weighs more: a pound of feathers or a pound of bricks?" The answer is that they weigh the same, but they surely won't take up the same amount of room. One piece of a brick might weigh a pound while it might take a bucketful of feathers to weigh a pound. Same is true with ingredients, especially the kind that can pack down, like flour and brown sugar. Depending on how you measure your flour using a cup measure, a cup can weigh anywhere from 4-6 ounces. That's a huge difference, especially when you're talking about multiple cups. In a recipe that calls for "4 cups of flour," your four cups could weigh 16 oz (1 pound) or as

much as 24 oz (or 1 1/2 pounds). That extra flour can end up causing your cake to be dry, crumbly and inedible. So, always weigh. Always.

- Prepare your pans for baking--In flat-bottomed cake pans, I like to use pan spray and then line the bottom of the pan with a circle of parchment paper (you can also use non-stick foil). Then, I usually spray the parchment for good measure. In fluted pans (like a Bundt pan), I spray the inside of the pan liberally with pan spray and then knock a couple of handfuls of flour in the pan until it's evenly coated. I knock out the excess flour (into the sink, the garbage, or sometimes on the back corner of the house) and then it's ready to go.
- Preheat the oven--Even after your oven "says" it's preheated by beeping at you, only the air in the oven is at the correct temperature. You want to preheat the oven well enough that the actual oven walls are as hot as you need them to be. This keeps all the heat from escaping when you open the door to bake your cake. It also lets the oven temperature recover more quickly.

❖ ***Mixing Methods for Cakes***: Methods for mixing batters and doughs were created primarily to a)ensure even distribution of ingredients, b)ensure optimal leavening and c)to manipulate the amount of gluten formed. This last is primarily done by changing when water-type ingredients are added to the mix as well as by how much agitation the mix gets *after* the water is added. The earlier water is introduced to the flour, the more gluten will form. Also, the more water introduced, the more gluten is formed.

- *The Creaming Method*: Makes a cake nicely balanced between tender and sturdy. Cakes made with this method have a fairly rough but moist crumb. They also rise nicely and are good for making carved and/or tiered cakes because there is a fair amount of gluten development with this method.
  - Cream butter until smooth.
  - Cream butter and sugar together until light and fluffy.

- Add the eggs, one at a time, beating well between each addition and scraping the bowl as necessary.
- Whisk together all dry ingredients (flour/spices (if any)/leaveners/salt) and add alternately with the liquid (water/milk/buttermilk, etc), beginning and ending with dry (dry-wet-dry-wet-dry)

➢ *The Two-Stage Method*: Makes a cake that is tender with a velvety crumb. Compared to a cake mixed with the creaming method, it doesn't rise as high, but the crumb is very tight and even, and the cake almost melts in your mouth. Not as good for tiers/carving because of the relatively small amount of gluten produced.

- Whisk together all dry ingredients in the mixer bowl, including sugar.
- Mix in fat (softened butter or shortening) along with 1/4 of the liquid and all the eggs.
- Beat on medium/medium-high speed for a couple of minutes, until light and fluffy. Scrape bowl as necessary.
- Beat in the remainder of the liquid in three additions.

❖ ***The Baking Process***: How baking happens once you put your batter or dough in the oven

➢ *Gases form and expand*--heat causes the gases (air and carbon dioxide, given off by the baking soda/powder's reaction with liquids and/or heat) to expand

➢ *Gases get trapped in air pockets*--you create a bunch of little holes in the batter with both the creaming method and the two-stage method. These holes trap the expanding gases and expand right along with the gases. Of course, some gas might escape, but the majority gets trapped by gluten and/or proteins in an egg foam, giving us rise.

➢ *Starches gelatinize (swell)*--Beginning at about 140F, the starches expand as they absorb moisture. They also firm up, adding to the structure of the cake.

- *Proteins coagulate (solidify)*--Starting at around 165F, the gluten and egg proteins start to coagulate, also adding to the structure.
- *Moisture evaporates*--Evaporation happens throughout the baking process. This is not a bad thing, because a lot of time, you need the extra water to make sure everything gets mixed up well, but then you don't need all of it in the finished product (otherwise your cake might fall apart). There are many factors that can influence how much water evaporates including:
  - baking time
  - oven temperature
  - baking in a pan or on a stone
  - surface area of the product
- *Fats melt*--When the fats finally melt, some of the gases that are trapped by the air pockets in the fat is released. Butter melts at a relatively low temperature while shortening melts at a relatively high temperature. The trick is to pick the right fat for the job. You want to make sure that your starches and proteins are firming up nicely (165F) so that a nice crumb structure is left even after the fat melts and the gases escape.
- *Crust forms and browns*--Of course, water will evaporate from the surface of the product first which leaves the surface dry. When dry, it begins to brown. Part of this is because the sugars present caramelize. Another part of browning is caused by chemical reactions among sugars and proteins across a broad spectrum of temperatures. These are called the Maillard reactions. Along with the proteins in the flour and sugar, milk and eggs (both contain proteins, and milk also contains lactose, or milk sugar) also contribute to browning.
- *Cooling*--If you've ever cut into a cake right after it comes out of the oven, it kind of disintegrates and tastes like eggs. Cutting hot bread results in a completely squashed loaf. Cooling is a necessary part of the baking process. While the proteins and starches have coagulated and gelatinized

(respectively), the product needs to cool so those proteins and starches can firm up. You know how rice gets crunchy when refrigerated or gravy gets thicker as it cools? Same principal. It is best to let baked goods cool to room temperature before cutting.

- *Storing*--Almost as soon as you take your baked good--cookie, cake or bread--out of the oven, it can start to dry out and go stale. While drying just means that water keeps evaporating into the atmosphere, with staling, the starch grains chemically change. The longer something made with flour sits around, the more the starches seem to want to go back to their original form: powder. While your cake isn't going to disintegrate into a pile of dust, what happens is that some of the water trapped in the gelatinized starch granules starts to leave, allowing the starches to set up a crystalline pattern. This leaves your baked goods not only dry, but kind of tasteless, crunchy and leathery. Staling happens most quickly at refrigerator temperatures but almost stops at freezer temperatures.

  To combat drying, it is best to keep baked goods wrapped up air tight. To combat staling, keep at room temperature or, best for bread, frozen. When I bake bread, I let it cool, slice it and then store it in freezer bags with as much of the air sucked out as I can manage. Then, I just pull out a piece or two at a time, as I need it. Stored this way, bread will taste almost just as fresh as...well, fresh...as the day you made it for up to a month.

  Making cake airtight is easy: frost it! The fat in the icing or frosting acts as a moisture barrier, keeping moisture in the cake where it belongs.

Yellow Cake

Exercise: Make a yellow cake using the same ingredients but different mixing methods.

Covers: ingredient function, ingredient acidity and balancing, mise en place, scaling ingredients and mixing methods

I'm intentionally choosing a formula that I've never used before to really prove the point that, although the ingredients are important, it's the mixing method that can make or break your cake. Rhyme-y! It also will go to prove the point that, within reason, you don't have to be married to the mixing method suggested in the directions of the recipe. This yellow cake is from Smitten Kitchen:

http://smittenkitchen.com/2009/07/best-birthday-cake/

We'll make one layer using The Creaming Method and one layer using The Two-Stage Method. The original mixing method is a modified creaming method which I'm sure works just fine.

4 cups plus 2 tablespoons (480 grams) cake flour (not self-rising)
2 teaspoons (10 grams) baking powder
1 1/2 teaspoons baking soda
1 teaspoon (5 grams) table salt
2 sticks (1 cup, 1/2 pound or 225 grams) unsalted butter, softened
2 cups (400 grams) sugar
2 teaspoons (10 ml) pure vanilla extract
4 large eggs, at room temperature
2 cups buttermilk (475 ml), well-shaken