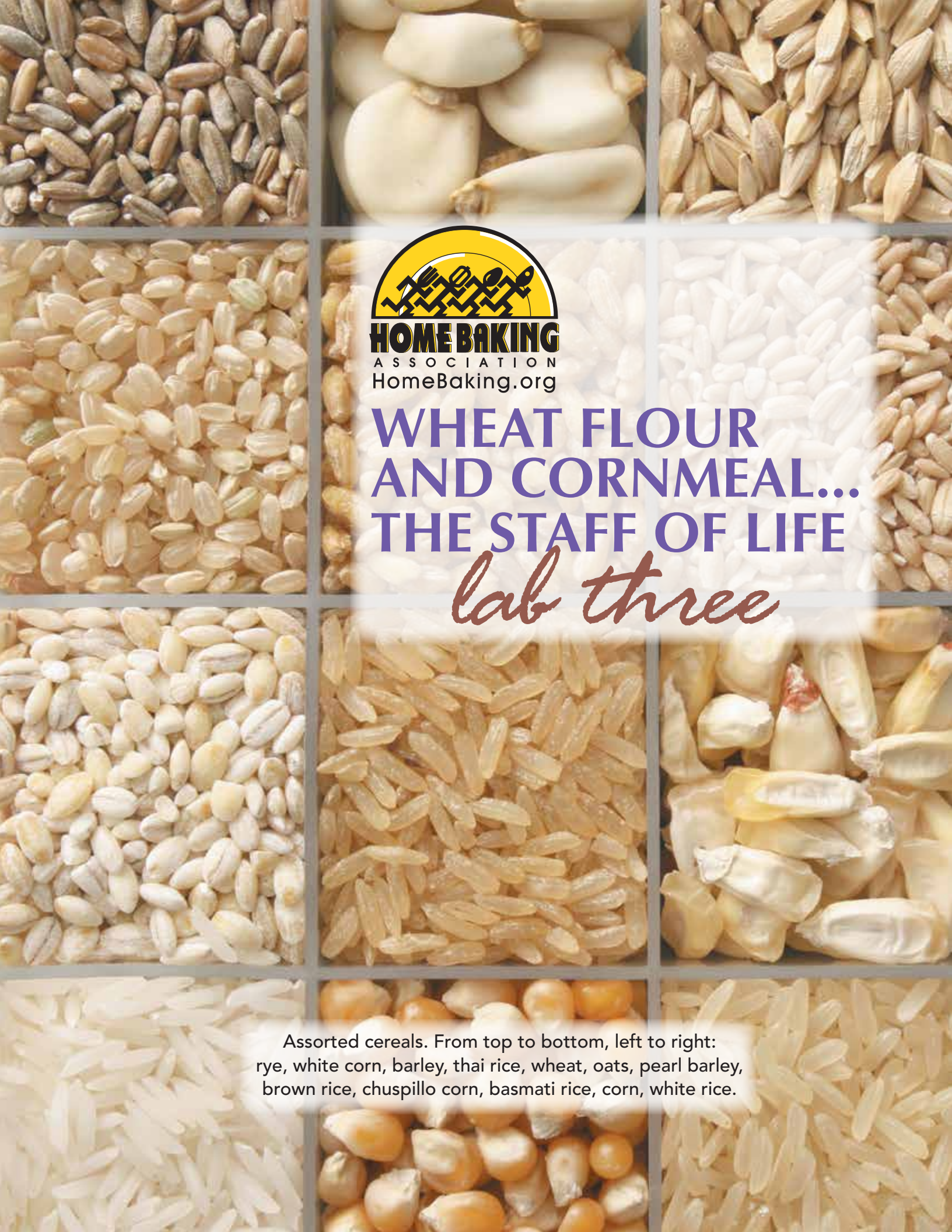


HOME BAKING ASSOCIATION
HomeBaking.org

WHEAT FLOUR AND CORNMEAL... THE STAFF OF LIFE

lab three

Assorted cereals. From top to bottom, left to right: rye, white corn, barley, thai rice, wheat, oats, pearl barley, brown rice, chuspillo corn, basmati rice, corn, white rice.

WHEAT FLOUR AND CORNMEAL...THE STAFF OF LIFE

Lab 3

Locate Family & Consumer Sciences Education Standards 3.0 (2018), STEAM and P21 connections to this lab in the Appendix.

Introduction: The Roman goddess Ceres is the source of our word for the grains people eat–cereal grains. Eight cereal grains largely sustain and nourish humankind–staples–and are recorded in primitive history: varieties of millets, oats, barley, wheat, (emmer, einkorn, spelt) sorghum, rye, corn and rice.

Outcomes:

1. Classify ancient grains and pseudo grains available for baking.
2. Recognize eight staple cereal grains.
3. Identify the three major components of a grain kernel – the bran, germ and endosperm – and know from which component flour or cornmeal is obtained.
4. Identify a variety of enriched and whole grain foods available in U.S. supermarkets.
5. Differentiate wheat into six classes and between wheat flours, enriched all-purpose, bread, cake, pastry, self-rising and whole wheat, and how the protein (gluten) content relates to their end uses in baking.
6. Practice measurement of liquid and dry ingredients in baking.
7. Prepare from basic ingredients a whole grain wheat or corn bread.
8. Apply mixing and kneading skills for a quick bread or yeast bread.
9. Evaluate the taste, texture, color and appeal of a whole grain bread.
10. Plan and organize the introduction of a whole grain bread into a home, school or community meal.
11. Measure the consumer response to a whole grain product introduced in a dining environment.
12. Calculate the results of the product survey to assess product acceptance.
13. Critique the results and offer adjustments to the recipe or serving situation if consumer responses are below the 60th percentile of acceptance in the consumer product taste test.

Terms and Techniques

Look terms up in Glossary and know their meaning.

Agriculture
All-purpose flour
Ancient grains
Batter
Bran
Bread
Bread flour
Cake flour
Cereal grain
Cornmeal
Corn starch
Cultivation
Degerminated
Dough
Endosperm
Einkorn wheat
Emmer wheat
Enriched
Fermentation
Flour
Germ
Gluten
Hard wheat
Kneading
Mill
Muffin (mixing) method
Multi-grain
Pastry flour
Protein
Proof dough
Red wheat
Rolled oats
Rye flour
Self-rising
Soft wheat
Staple
White wheat
Whole wheat
Whole grain

Wheat and Corn Timeline:

17,000 years ago *Humans gathered seeds and grains from grasses. Husks were rubbed off and the grains chewed "on the move," while hunting or moving—an early form of fast food*

10,000 years ago *Humans began to select seed, plant, tend and harvest (cultivate) early kinds of wheat called einkorn, emmer and spelt—agriculture—in the "cradle of civilization" between the Tigris and Euphrates Rivers*

9,000 to 8,500 years ago *Ancient texts and glyphs show barley was grown at Jarmo, Iraq*

8,000 years ago *Records of grinding and baking early wheat bread on stones by Swiss Lake dwellers*

5,000 years ago *Egyptians fed pyramid builders by baking yeast leavened breads*

3,000 years ago *Maize, or corn, was the "staple" grain of Central, South and North American natives. European colonists coming to North America would not have survived without the native corn to eat! Wheat, rye, barley, oats and millet were not growing in the U.S. when they arrived*

2,400 years ago *Rye, once a "weed" in wheat and barley fields, became domesticated in Germany, Scandinavian countries and the Russian Federation*

1777 *Wheat introduced in North America as a hobby crop*

2015 *Five to 10 oz. grain food servings daily are recommended—more for teens. Half of these should be whole-grain*

For Teacher:

- Review PowerPoints, "From Field to Flour" and "From Flour to Table" at ***nationalfestivalofbreads.com/nutrition-education/facs-labs***
- View at ***namamillers.org,*** "Did You Know" Baking Food Safety video. Take a flour mill tour, ***namamillers.org/resources/kid-zone***. View wheat Infographics – Six Classes of Wheat, Modern Wheats, Carbs for Athletes, Wheat Foods of the World and more at ***WheatFoods.org/resources/74.***
- View a *Baker's Dozen Lessons for Better Baking* DVD Flour (9:30) or DIY Everyday Bread video at DIY Baking Channel, ***HomeBaking.org***.
- Prepare to introduce the students to the concepts of staple foods and cereal grains (see Introduction and Timeline).
- List eight most widely consumed cereal grains; bring an example or empty package/label for each if possible.
- Visit ***panhandlemilling.com***, Ingredients and Ancient Grains Guide at ***kingarthurflour.com/guides/baking-with-ancient-grains*** to see ancient and specialty wheats; ***Organicgrains.com*** too.

Copy for student, Baking Portfolios
Download online: Baking Food Safety 101, ***HomeBaking.org*** and A Kernel of Wheat pdf, ***nationalfestivalofbreads.com/nutrition-education/a-kernel-of-wheat.***

Download from ***WheatFoods.org***
Click on Resources; Wheat Facts:
All About Gluten
Ancient Wheat and Pseudo Grains
Flour 101
How Flour is Milled
Six Classes of Wheat
Whole Grain and Enriched Products

Find All About Corn, All About Oats, and All About Wheat fact sheets at ***namamillers.org/education.***

Found in Lab 3
Alternative Flours Worksheet (p. 13)
A Matter of Taste Form/Lab Rubric (p. 14)
Baking Science Experiment (p. 7)
Flour Chart (p. 8)

Found in the Appendix
Count the Costs Worksheet
Mise en place Chart
Temperatures for Yeast Bread Production
What Happened to the Yeast Bread

Take 10 Skill Drills:

1. View Did You Know video at ***namamillers.org*** on baking food safety.
2. Scoop, Spoon, Scale activity: Have lab groups measure ½ cup each of bread flour, cake flour, corn meal, corn starch, whole wheat flour, Ultra-grain and all-purpose flour. Have them weigh and record the weights of each in ounces and grams. (Observe: each will weigh a different amount even though each is ½ cup.) Save flour for the Baking Science Lab.
3. Name one food you enjoy made from each: corn, wheat, oats, barley, and rye.
4. Locate on a world map the countries first known to grow wheat (Iraq); corn (Central America); rye (Germany); barley (Finland); oats (Scotland); rice (China).
5. Write a one-page story about a type of bread your family enjoys, what meal or occasion you serve the bread and if possible where—or with whom–the recipe or tradition began.

Wheat field, Photo courtesy of Kansas Wheat Commission

Computer Lab: Check out these grain and grain food web-sites:

The Cook's Thesaurus – Baked goods, Grains, Grain Products, ***foodsubs.com***
Colorado Wheat Commission – ***coloradowheat.org***
Discovering America's Bakeries – ***bakemag.com/thebakingchannel/discoveringamericasbakeries.aspx***
DIY Baking Channel Videos – ***HomeBaking.org***
Farmer Direct Foods – ***farmerdirectfoods.com, kingarthurflour.com***
Flour Mills – Visit historic U.S. flour mills at ***HomeBaking.org***, Members
From Field to Flour, PowerPoint, ***nationalfestivalofbreads.com/sites/default/files/field-to-flour.pdf***
Grain Foods – ***choosemyplate.gov/***, click on "Grains" section, ***choosemyplate.gov/grains***
Historic Corn and Wheat Mills – ***heckersceresota.com***; Hopkinsville ***sunflourflour.com; hudsoncream.com***; North Dakota Mill – ***ndmill.com; renwoodmills.com***;
Kansas Wheat – ***kswheat.com, nationalfestivalofbreads.com***
North American Millers' Association – Did You Know Flour Food Safety; Wheat, Corn and Oat Milling. Kids' Zone, ***namamillers.org***
North Dakota Mill – ***ndmill.com***
North Dakota Wheat Commission – ***ndwheat.com***
Our Flours – Farmers and milling flour videos, ***kingarthurflour.com/flours***
South Dakota Wheat Commission – Consumers' section, ***sdwheat.org***
Stone-Buhr Flour – Locate a Pacific Northwest wheat farmer, ***findthefarmer.com***
Texas Wheat, Wheat 101, ***texaswheat.org***
Washington Grain Commission – ***wagrains.org***
What's a Whole Grain? ***WholeGrainCouncil.org***
Wheat Montana follows Wheat Mania Wheat Montana – ***wheatmontana.com***
Wheat Foods Council – ***WheatFoods.org***
Wheat Mania! All About Wheat or added wheat gluten – ***wheatmania.com***

Photo courtesy of Oklahoma Wheat

Grain Web-site Work Sheet

Provide each student copies of the web-sites, p. 3, and worksheet, p. 4.
Students: Visit 3-5 web-sites. Make notes about what each site offers about grains we bake with, flour, milling and baking. Consider developing a Student DIY Baking Topic with one.

Student Name: _____ Date sites visited: _____

1. Site Name: _____ URL: _____

List 4 featured sections: _____ _____

_____ _____

Section(s) I visited: _____ _____

Link(s) I visited: _____ _____

How I would use information on this site:

1. _____

2. _____

3. _____

2. Site Name: _____ URL: _____

List 4 featured sections: _____ _____

_____ _____

Section(s) I visited: _____ _____

Link(s) I visited: _____ _____

How I would use information on this site:

1. _____

2. _____

3. _____

3. Site Name: _____ URL: _____

List 4 featured sections: _____ _____

_____ _____

Section(s) I visited: _____ _____

Link(s) I visited: _____ _____

How I would use information on this site:

1. _____

2. _____

3. _____

Baking Science:
Flour is Not Just Flour

For Teacher:

1. Obtain different flours to show, compare labels and bake with for this lab. (See Supermarket Flour Finds list)
2. Oat flour may be made by processing oatmeal until it is a flour.
3. Show baked or cereal product examples that are made from the different flours.
4. Show how calibrate and use a food thermometer and electronic scales to weigh ingredients. (Salter electronic scales are affordable. Visit *kingarthurflour.com*)
5. Need to special order flour? Visit *HomeBaking.org*. Click on Member Links for whole grain and variety flours and mixes.
6. Prepare a list of ingredients/equipment for the Baking Lab recipe(s) you will do.

Lab Introduction:

Using the right flour for a product is critical to baking success. One of the first things a baker learns is that every type of wheat flour and non-wheat flour is different in protein and gluten development and determines how and what you will bake from it.

Every year, wheat will vary due to growing conditions. See Computer Lab. Six types or classes of wheat are grown in different climates and geographic areas: hard red spring, hard red winter, hard white, soft red winter, soft white and durum. Millers purchase wheat from a class and variety that will produce the flour their customer (bakeries, cereal, pasta or food company) specifies.

About Flour:

Professional bakers stock the right flour for the products they bake. They will seldom use an "all-purpose" flour. Millers mill flour specifically for the baker's needs for protein, mixing tolerance and more factors.

Home bakers often use all-purpose flour for many products. Avid home bakers will often stock several types of wheat flour: (Ex:) cake, pastry, bread, whole wheat, and all-purpose flour, short patent flour, self-rising cornmeal and self-rising flour and special mixes. (See next Flour Chart and Glossary.)

For variety, bakers also buy flours made from non-wheat grains (such as rye, soy, cornmeal, oats, brown rice, amaranth and specialty wheats such as einkorn, emmer and spelt), to make "multi-grain" breads.

In multi-grain baked products, only 1/4 (25%) or less of the recipe or formula's flours are non-wheat flours or meal. 75%, or more, wheat flour or added wheat gluten is needed to provide structure.

Supermarket Flour and Cornmeal Finds:

Supermarkets sell a variety of flours and baking mixes. Use label savvy and a variety of package labels to learn about:

- All-purpose (enriched, unbleached or bleached)
- Baking mixes: companies select the best-suited enriched wheat flour for the product
- Bread flour (enriched, unbleached or whole wheat flour made from hard, red or white wheat)
- Bread machine or baking mixes (enriched, whole grain)
- Cake flour (enriched, bleached)
- Corn flour, the starchy (endosperm) portion of de-germinated corn (also corn starch)
- Pastry flour (enriched or whole wheat)
- Self-rising cornmeal: yellow or white enriched de-germinated cornmeal blended with leavening and salt
- Self-rising flour: enriched, all-purpose flour with leavening and salt
- Short patent flour: unbleached or bleached; enriched short patent is the finest separation of the flour
- Ultragrain® all-purpose flour (very fine; 30% whole grain, 70% all purpose)
- Ultragrain® whole wheat flour (white ultra-fine whole wheat flour)
- Variety flours are made from many kinds of grains, legumes and dries vegetables
- Whole wheat flour, hard (higher protein) or soft (lower protein); may be labeled "stone ground" or "graham"
- Yellow or white cornmeal: wholegrain or degerminated

Label Savvy Skill Builder

Read package labels from flours and cornmeal to learn:

1. What company made the flour?
2. Where is the flour milled?
3. From what grain or grains has the flour, baking mix or cornmeal been made?
4. Can you tell from what **wheat class** the flour is made?
5. Is it enriched?
6. Is it bleached?
7. Is it whole grain or have the germ and/or bran been removed?
8. Compare Nutrition Facts labels for carbohydrate, vitamins, protein, fiber, sugars
9. What influences you to buy, or not buy, this flour or mix?
10. What would you bake from each product?

Scoop on Baking Flours

All-purpose flour: acceptable in cookies, cakes, pancakes or waffles, muffins (quick breads), pizza crust, and some yeast breads. It is enriched and is made from hard, soft or a blend of wheat—usually produced from wheat grown near the mill. May be bleached or unbleached, is enriched or now may be an ultra-fine whole grain blend.

Ancient grains: wheat and its ancestors, emmer, einkorn and spelt, plus others. *WheatFoods.org;* Ancient Grains Guide*, blog.kingarthurflour.com/2017/02/10/baking-ancient-grains.*

Bread flour: unbleached, higher protein (11 to 14%) "strong" or high gluten flour made from hard winter or spring wheats; best for baking yeast bread products (bagels, hearth breads, pizza crusts, pan bread, rolls, artisan breads, sweet rolls)

Cake flour: enriched, bleached (to modify gluten strength), low protein (7-8%) flour for high ratio, angel food and chiffon cakes.

Enriched: made from the endosperm of the wheat kernel – three B vitamins, iron, folic acid and sometimes calcium are added.

Gluten flour: flour produced by extracting some of the starch to make it higher protein; used to produce lighter, lower starch breads; often combined with low-gluten strength ingredients (non-wheat flours or meal).

Graham flour: coarse whole wheat flour named after Rev. Sylvester Graham, an early health advocate of eating whole grain flour products, 1820 to 1851.

Pastry flour: bleached or unbleached enriched low protein (8-9%) flour used for cookies, brownies, sheet cakes; made from soft winter red or white wheat .

Patent and short patent: patent is the innermost 70 to 80% of the endosperm. "White" flour is another term for enriched (not whole wheat) flour – it may be cake, all-purpose, pastry or bread flour.

Stone ground flour: whole wheat ground into flour between mill stones without separation or sifting.

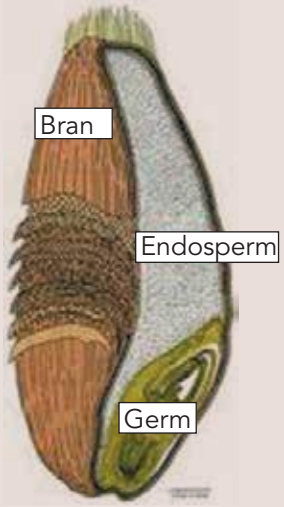
More info: *wholegrainscouncil.org*

Variety flour: may be made from a wide variety of grains, legumes or vegetables; bakers often use 5-25% of the total flour as a variety (non-gluten forming) flour.

Vital wheat gluten: dried gluten, derived from flour by removing the starch. Used to increase dough strength in breads with non-gluten flour, bran or whole grain. It is 80% protein. Will be added to dough at 1 to 4% of flour weight plus added water 1 to 1.5 times the weight of the gluten.

Whole wheat: contains all the parts of the whole kernel of wheat – bran, germ and endosperm.

Whole wheat photo:
Name the three major components of a whole grain.



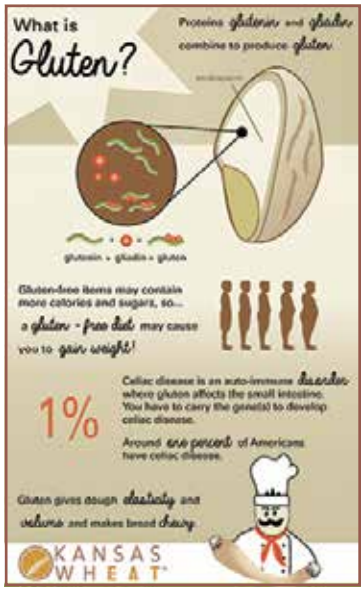
*Courtesy North American Millers' Association - **namamillers.org***

For Teacher:

You may organize the baking science experiment lab in several ways (p. 8). Use a favorite graphic organizer to record results. You may wish to repeat (replicate) the same tests between labs to compare results.

Option 1: Have two or more students use each of the flours to see how their results compare. This is called a "replication" to verify accuracy of results. Observe, record and compare results.

Option 2: Demonstrate experiment and have students assist you with the mixing. Have students time length of mixing and use the same mixing speed to control results. Observe, record results and compare.



Baking Science Experiment: Flour Absorption and Gluten Development

Question to test:

What difference(s) will you observe when substituting different flours one-for-one with all-purpose flour in a mixture?
Control: Mix each type of flour/water mixture for the same amount of time and at the same speed.

Student name(s): _____ Lab:_____ Date:_____

Our lab compared all-purpose flour with _____ flour _____ flour _____ flour

Hypothesis: _____

Lab Supplies:

- ❑ Choose 4 or more flours
  Use 1/2 cup (2 oz. or 55 grams) of each flour
  - ❑ All-purpose flour (bleached, unbleached)
  - ❑ Cake or pastry flour
  - ❑ Bread flour
  - ❑ Whole wheat flour (hard red or white OR pastry/soft wheat)
  - ❑ Corn starch
  - ❑ Cornmeal, yellow or white
  - ❑ Rye, barley, oat, sorgum, rice or other non-wheat flour
  - ❑ Ultragrain® flour *ultragrain.com*
- ❑ **Water (3 oz./85 ml)**
- ❑ **Measuring cups or scales**
- ❑ **Four or more bowls and electric mixers** (use standard beaters, not dough hook).

Basic Experiment: What to do.

1. Scoop each type of flour out of its bag and into a separate bowl; label.
2. Stir each flour or cornmeal with a large spoon to "fluff" or unpack the particles.
3. Spoon flour into a ½ cup dry measuring cup, heaping it up, then level it off (do not pack, shake or push down on the flour in the cup); **OR,** use an ingredient scale and weigh 2 oz. or 55 grams of each flour.
4. Put each type of flour in a medium mixing bowl. Label with flour name. Use a liquid measuring cup or beaker, placed on a flat surface. Add 3 oz. (85 g/100ml) cold water.
5. Mix each flour and water mixture on LOW speed 1 minute; record observations. Continue mixing on MEDIUM speed 2 minutes. Record observations. **Be consistent in mixing speed and time.**

1, 2, 3 Report:

1. List the flour type(s) your lab compared.
2. Describe the differences found in the mixtures after 1 minute mixing and 3 minutes total mixing.
   - **Use descriptions such as:** how fluid or stiff; development of batter structure (gluten strands developing, lumpy, no strands), how much water was absorbed (stiff, fluid, medium stiff) batter/dough strength (hard to mix, not hard to mix)
3. Use the **Flour Chart** and the **Need to Know Flour Basics,** (p. 8) to help you hypothesize what differences you'll observe.

	One Minute Mixing	Three Minutes Mixing
Bowl 1: All-purpose flour (Control)		
Bowl 2: _____ flour		
Bowl 3: _____ flour		
Bowl 4: _____ flour		

Flour Chart: Wheat Classes and Major Wheat Flour Types Used in Baking

Wheat Classes and Flour Types	Flour Uses	Protein	Dough Strength	Water Absorption	Mix Time	Gluten Forming
Hard Spring Red or White	Bagels, Hearth breads	12-14%	High	High 60-65%	Long Mix time 12-14 minutes	High gluten forming
High Gluten	Thin pizza Pizza crust	13.4- 14.4%				
Strong Patent	Hearth bread	12.8-13.2%				
Spring Patent	Breads Rolls	12.4-12.8%				
Hard Winter Red or White	Pan breads Artisan bread	10-12%	Med	Medium 50-60%	Medium Mix gluten time 8-12 minutes	Medium forming
Winter patent	Sweet dough Thick crust Pizza	11-12%				
All-purpose	Quick breads Cookies	10-11%				
Soft Winter Red or White	Cookies Brownies	7-9%	Low	Medium	Short Mix time	Low gluten forming
Pastry	Sheet cakes	8-9%				
Cake	High Ratio cakes: angel	7-8%				

Need-to-know flour basics.

- Flour can be made from any ***grain***–such as wheat, rye, oats, corn, millet, triticale, quinoa, brown rice, sorghum…
- Wheat flour may be made from red or white wheats.
- Flours made from wheat are the principle flours we use in baking because of the proteins ***glutenin*** and ***gliadin*** that combine to form ***gluten***.
- The type or class of wheat milled to make the flour makes a difference in the protein (gluten) quality and quantity in the flour. ***"Hard" wheat classes*** make flour that is higher in protein. These flours are more absorbent due to the higher gluten or protein. When mixed they will form stronger gluten structures, so are great for yeast loaves, buns, pizza crust, soft pretzels, whole grain breads. ***"Soft" wheat classes*** often contain less protein and form weaker gluten structures. These will make more tender products such as biscuits, scones, muffins, cookies, cakes, pastries, crackers. Pastry and cake flours are lower in protein and ideal for these products—flour made from any of these may be whole wheat enriched.
- New technology now produces ultra-fine wholegrain flour—Ultra-grain Flour all-purpose or whole wheat hard and soft flours are examples. See *ultragrain.com*.
- ***Gluten*** is formed when flour and water are mixed. Gluten is the elastic "stretchy" strands that give structure to dough. It can hold gas from the leavening agent and help the batter or dough expand and become airy.
- Too much gluten makes a product too dry, crumbly, tough, or heavy.
- Flour or meal made from **non-wheat grains** (rye, oats, corn, spelt), **seeds** (amaranth, flax), **legumes** (soybeans, lentils) and even **vegetables** (potatoes, garbanzo beans) are low in gluten or may be "gluten-free." Their gluten protein is low or non-gluten forming. Low or non-gluten forming flours are often used as only 5 to 25% of the total flour weight so a lighter product can be produced. Ex: 1 cup wheat flour = ¾ cup wheat flour + ¼ cup oat flour (or non-wheat flour)

Gluten-free flours.
See list Lab One, page 8.

- Learn more. Download Resource, Gluten and the Diet, *WheatFoods.org*
- National Celiac Association, *csaceliacs.org* Gluten Free guides.
- International Food Information Council, *foodinsight.org*

First Experience:
Everyday Muffins

For Teacher:

- Demonstrate or view a *Baker's Dozen Lessons for Better Baking* DVD "muffin mixing method" so students will know how much to mix a muffin.
- OR view DIY. Food Channel video Cornbread at *HomeBaking.org*.
- See Muffin Baking Tips, Lab 9, p 7.
- Access How to Bake a Perfect Muffin, ***chsugar.com/baking-tips-how-tos/how-to-make-perfect-muffins***

Labs will prepare four (or more) batters using Everyday Muffin recipe.

Be sure to:

- Weigh or carefully measure all ingredients
- ONLY vary the type of flour used (use exactly the same other ingredients)
- Label each mixing bowl and muffin tin with type of flour used in that batter
- Write each type of flour on small strips of plain paper; tuck into the side of one muffin cup in each pan to avoid confusion

Students will:

1. Make Everyday Muffins, varying the flour types and compare with the control muffin recipe to observe the difference in flours and cornmeal.
2. For one variable product, use a muffin mix to compare with the control recipe.
3. Read the recipe from top to bottom.
4. Prepare a *Mise en place* Chart for their lab.
5. Prepare their muffin, sample and compare with variable muffins using the Lab Rubric and *A Matter of Taste* to record reactions to each.
6. Prepare a report using the Alternative Flours Worksheet and summaries of the responses to their products.
7. Use the Critical Thinking Questions to assist in reporting and understanding whole grain knowledge.
8. Identify how much whole grain consumers should average and what will make the muffin whole grain.

Supplies Needed:

- ❑ Variety of flour types (whole wheat, all-purpose, bread, pastry, cake, Ultragrain, cornmeal)
- ❑ All-purpose baking or muffin mix
- ❑ All additional recipe ingredients
- ❑ Ingredient scale OR standardized measuring utensils
- ❑ Spoons, spatula/level
- ❑ Muffin pans
- ❑ Pot holders
- ❑ Wire cooling racks

• **Copies:**

Alternative Flours Worksheet, (p. 14)

A Matter of Taste/Lab Rubric form, (p. 15)

Mise en place Chart (Appendix)

Sample Lab Team Options

Team #1: All-purpose flour

Team #2: Ultragrain® all-purpose flour (blend)

Team #3: 50% (½) all-purpose,
50% (½) whole wheat flour

Team #4: Cake or pastry flour

Team #5: Use half (½ cup) oatmeal

Team #6: 100% whole wheat flour

Team #9: Use half (½ cup) cornmeal

Question to Test:

What difference(s) in texture, volume, color and flavor do you think substituting (name of substitution) _____flour for all-purpose flour will make?

Hypothesis: _____

_____

_____

Critical Thinking:

1. Evaluate the muffins using the Lab Rubric form (p. 14). What could be improved? Did any of the lab options completely fail? Which one was the most desirable?
2. What types of grain flour or meal will make this muffin "whole grain?" (A. 51% or more (1/2 cup plus 1 T. or more whole wheat flour, whole cornmeal, oatmeal or combination of Ultragrain® flour plus whole cornmeal or oatmeal). One whole grain muffin made with a little more than half whole grain flour or meal will provide ½ whole grain serving (9 grams).
3. How much whole grain is the minimum people should average each day? (A. 48g or 3 whole grain servings out of the 6 or more grain servings recommended).

Everyday Muffins

Yield: 6 (2.2 oz./61g) medium muffins Preparation Time: 15 minutes Baking Time: 18-20 minutes

Ingredients	Measurement	Weight
All-purpose flour*	1 cup	4 oz /115g
Baking powder	2 teaspoons	1/4 oz /7g
Salt	1/4 teaspoon	1.5g
Sugar	2 tablespoons	0.9 oz /25g
Small egg, beaten	1 whole egg	1.5 oz /42g
Low-fat milk	½ cup	4 oz /125 ml
Melted butter or cooking oil	2 tablespoons	1 oz /28g

*Each muffin provides 18g whole grain (1 serving) when made with whole grain flour and or cornmeal.

Before You Start:

- Assemble ingredients and tools (*mise en place*).
- Stir flour if using dry cups to measure.
- Spoon flour into dry measuring cup; level.
- Preheat oven to 425˚ F.
- Grease or spray the bottoms only of six, medium (2 ½-inch) muffin cups.

Directions:

1. In a medium mixing bowl, using a wire whisk, blend the flour/meal, baking powder, salt and sugar.
2. In a separate small bowl, combine beaten egg, milk and melted butter OR vegetable oil. Add to dry mixture, stirring only until moistened. Do not over mix—batter will be slightly lumpy.
3. Drop by large spoonfuls (ice cream or #20 scooper) into six medium (2 ½-in) greased muffin cups, fill each muffin cup 2/3 full.
4. Bake at 425˚ F., 18 to 20 minutes, or until golden. Cool briefly on wire rack, and serve warm with butter, jam, or honey or honey butter.

Nutrition Facts

Serving Size (61g)
Servings Per Container

Amount Per Serving

Calories 150 Calories from Fat 45

	% Daily Value*
Total Fat 5g	8%
Saturated Fat 3g	15%
Trans Fat 0g	
Cholesterol 40mg	13%
Sodium 260mg	11%
Total Carbohydrate 22g	7%
Dietary Fiber 2g	8%
Sugars 7g	
Protein 4g	

Vitamin A 4% • Vitamin C 0%
Calcium 10% • Iron 4%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300 mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

For Teacher:

For classrooms without ovens: Muffin batter may be thinned slightly with milk and used for pancakes when ovens are not available. Oil and pre-heat griddle to 400°. Add 2 T or 1/8 cup additional milk to thin batter. Scoop ¼ cup batter onto griddle for each pancake. When bubbles appear and edges are beginning to brown, flip once.

Tip: Everyday Goal: Three servings of whole grain foods (48g whole grain). Resources at *wholegrainscouncil.org*

Intermediate Experience
English Muffin Batter Bread

Students will:

1. Read the recipe from top to bottom.
2. Prepare a *mise en place* chart for their lab.
3. Prepare English Muffin Bread, sample and evaluate the bread using the Lab Rubric and Alternative Flour worksheet, p. 13-14.
4. Write a product quality report based on the Lab Rubric outcomes and understanding of how various flours and meal are used in baked goods.
5. Identify how much whole grain consumers should average.
6. Define what will make the bread a "whole grain" bread and the weight in grams of whole grain in your team's recipe/formula.

Critical Thinking:

Prepare a written report–use the back of the Alternative Flours worksheet page or a separate page. Use correct spelling and full sentences.

1. Describe physical observations of your lab's batters after 1 minute and when mixing is completed. Lab teams may want to take digital photos.
2. Label the flour-type used in each variable product. After cooling, cut loaf in half to record what the crumb (interior) looks like, how dry, moist, dense, etc. the product is, and other attributes.
3. Taste a small bite of each bread or muffin. Record how each product tastes. (*A Matter of Taste* form)
4. Use Alternative Flour worksheet, Lab Rubric and *A Matter of Taste* information to help prepare a summary: What flour type or blend would you recommend for this product? Was your hypothesis correct or incorrect? If incorrect, describe why.
5. Why would using a variety of flours be good?
6. Have each lab group share their reports.

Photo courtesy of Oklahoma Wheat Commission

Sample Lab Team Options

Team #1: All-purpose flour

Team #2: 50% all-purpose flour, 50% whole wheat flour

Team #3: 100% Ultragrain® flour

Team #4: Bread flour

Team #5: 20% cornmeal (½ cup), 80% bread flour (2 cups)

Team #6: 100% whole white or red wheat flour

English Muffin Batter Bread

Yield: 1 Loaf Preparation Time: 90 minutes or 2 days* Baking Time: 30 minutes

Ingredients	Measurement	Weight
All-purpose unbleached flour	2 ½ cups	10 oz/285g
Fast rising yeast	1 ¼ teaspoon	1/8 oz/3.5g
Granulated sugar	1 tablespoon	½ oz/14g
Salt	1 teaspoon	¼ oz/6g
Baking soda	1/8 teaspoon	1/8 oz/0.6g
Milk, low fat	1 cup	8 oz/225 ml
Water, cold	¼ cup	2 oz/55 ml
Vegetable oil		
OR butter	1 tablespoon	½ oz/14g
Cornmeal	Less than 1/8 cup	½ oz/14g

Nutrition Facts

Serving Size (37g)
Servings Per Container

Amount Per Serving

		% Daily Value*
Calories 80	Calories from Fat 10	
Total Fat 1.5g		2%
Saturated Fat 0g		0%
Trans Fat 0g		
Cholesterol 0mg		0%
Sodium 150mg		6%
Total Carbohydrate 15g		5%
Dietary Fiber 1g		4%
Sugars 1g		
Protein 3g		

Vitamin A 0% • Vitamin C 0%
Calcium 2% • Iron 4%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

		Calories: 2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300 mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

Directions:

1. Heat (scald) milk in microwave about 2 minutes on high—until steaming (200° F). Stir in ice cold water. (Take temperature–mixture must not be hotter than 130˚ F.)
2. In a large mixing bowl, combine 1 ½ cups flour, yeast, sugar, salt and baking soda. Stir in liquids and oil or butter; add remaining flour.
3. Mix on low speed 1 minute; then mix on medium speed 5-7 minutes, using dough hook/attachment.
4. Grease or spray one 8 ½-in x 4 ½–in loaf pan; sprinkle with cornmeal. Spoon batter into the prepared pan. Cover lightly with plastic wrap sprayed with pan spray OR, go to 2-day plan below.* Let rise in warm (90 to 100° F.) place for 30 minutes. (Until doubled—batter above the edges of the pan.)
5. Preheat oven to 400° F. Bake for 25 to 30 or until all sides of the loaf are nicely browned.
6. Take the internal temperature of the loaf with a probe thermometer. Bakers go by interior temperature of loaf to know if loaf is done baking. Using an instant read probe thermometer, take the interior temperature of the loaf. (Insert thermometer in end of loaf.) Temperature should read 190-210° F.
7. Cool loaf on wire cooling rack—remove from pan after 5 minutes. Cool 15 minutes (minimum) or preferably to 100° F (interior temperature) before slicing.

*2 days: Spray a large plastic food bag with pan spray. Set loaf in bag and seal, leaving very small opening.

Refrigerate overnight. Take pans out of refrigerator 50 minutes before baking. Proceed with Step 5.

*Credits: Sharon Davis, Yeast Breads Made Easy, **kswheat.com***

Explore a wide variety of breads baked by Montana bakers, field to table, to choose your next bread to bake! ***wheatmontana.com/news-info/recipes***

Fun Facts: The average American eats 52 pounds of bread every year and 132 pounds of wheat flour per person.

- Oats were considered "poor man and horse feed," until the mid 1800's when human benefits became known.
- In some countries, "corn" refers to grain or wheat and "maize" means corn.
- More Wheat Facts at ***kswheat.com/domestic-marketing-and-consumer-information***

Alternative Flours Baking Lab Worksheet

Name: _____Hour _____ Lab# _____ Date _____

Product Name ☐ Everyday Muffins ☐ English Muffin Batter Bread We used _____ flours

	All-Purpose Flour	50% All-purpose 50% Whole Wheat	Cake Flour	Bread Flour	Rye, Cornmeal or Oat Flour	Whole Wheat Flour
Visual Differences in Batter/Dough						
Color of Baked Products						
Texture Rating						
Moisture Rating						
Flavor Rating						
Flour Type Recommendation Rating*						

*Ratings Texture = 1 → 5 (Soft Tough) Moisture = 1 → 5 (Very Moist Dry) Flavor Rating = 1 → 5 (Desirable Undesirable) Flour Type Recommendation = 1 → 6 (Best Worst)

1. On the back of this chart note what flour(s) you used in the lab. What is your hypothesis about the flour substitutions?
2. Write a summary of the experiment, your observations and an explanation of your texture, moisture, flavor and recommendation ratings.
3. If the product did not rate 60% or higher in most ratings, state what you might do to change the batter so that it would improve.
4. If the product was great, what would you name the product to sell it?_____ (Product Name)
5. Which products are whole grain? (A. Those with 51% or more whole grain flour meal)

*Baking Lab by: Sharon Davis, Family & Consumer Sciences Education, **HomeBaking.org***

Alternative Flours Worksheet: Connie Nieman, FCS Olathe H.S.

Lab Rubric

Variable flour/meal used in lab test: _____

	Very acceptable	Just okay	Not acceptable
Top and bottom crust	Evenly golden Not burned or pale	Edges browned	Very pale appearance Greasy or doughy Brown on only top OR bottom
Volume	Doubled in height	Raised somewhat	No change in volume/flat
Interior crumb	Moist, tender Not too dry	Moist and doughy Oily or greasy to eat	Dense, wet, crumbly or too dry Not baked completely
Flavor	Rich, a little sweet Wheaty, pleasant	Pleasant flavor	Too much oil or fat flavor Coats mouth; unpleasant
Keeping quality after 1 day	Still flavorful Good aroma/flavor	Edible But not best	Crumbly or off flavor Fat flavor; dry or tough

A MATTER OF TASTE
Lab Evaluation Form

How to use Evalution Form:

1) Tally each category – taste, color, aroma, appearance, would eat again.
2) Calculate the percentages making each category – Example: 8 out of 15 surveyed thought it very good=53%
3) Each overall category needs at least a 60% consumer positive approval before the product will sell.

Product Name Tasted: _____ Lab group:_____ Date: _____

I think the food product tastes: _____ very good _____ good _____ okay _____ improvements needed

The food tastes: _____ savory _____ sweet _____bitter _____salty _____ sour _____ not what I expected

The color is: _____ great _____ too pale _____ too dark _____ not right for the product

The aroma (smell) is: _____ inviting _____ too strong _____ too weak _____ not inviting

The food looks: _____ yummy _____ okay _____ improvement needed

The portion size is _____ just right _____ too small _____ larger than needed

I would enjoy eating this food again: _____ yes _____ no _____ maybe

Comments: _____

Photo courtesy of North Dakota Wheat Commission

Advanced Experience: Pilgrim Bread

For Teacher:

Demonstrate or have students review how to mix and knead bread dough

- DIY Baking Channel, ***HomeBaking.org***, Everyday Bread or Pizza Crust
- Bake for Good Kids, ***kingarthurflour.com/bakeforgood/kids***
- View how to shape loaves on a *Baker's Dozen Lessons for Better Baking* DVD OR on-line at ***HomeBaking.org*** DIY Everyday Bread video.
- Review the Baker's Percent example in Glossary to complete the Pilgrim's Bread formula.
- Provide students with Temperatures for Yeast Bread Production and What Happened to Yeast Bread Guides. (Appendix)
- Explore entering the National Festival of Breads OR view the winning bakers and breads at ***nationalfestivalofbreads.com***

Students will:

1. Prepare a whole grain yeast bread from colonial times, when wheat flour was precious and cornmeal and rye flour were added to make it go further.
2. Calculate the Bakers % for the ingredients in the formula. (See Bakers % example in Glossary)
3. Develop skills in mixing, kneading, portioning and shaping dough.
4. Conduct fermentation, proofing and baking of bread dough.
5. Use food thermometer to accurately determine when bread is baked and cool enough to package. Weigh dough and divide (portion) equally and record weight in recipe.
6. Work with local wellness professionals to test and introduce a new whole grain staple bread to their consumers or for their family.

Critical Thinking:

1. Weigh the dough after mixing. Record dough weight on recipe. Use this weight to divide the dough evenly when shaping into two loaves.
2. Calculate the Bakers % for the ingredients in the formula. (See Bakers % example in Glossary)
3. Weigh each baked loaf. Note the weight lost in baking. Why does each loaf weigh less; what was lost? (A. moisture)
4. How much will each unbaked loaf need to weigh to make a standard, one pound (net weight) loaf of bread? (A. 18 ounces)
5. Create a food label for the Pilgrim Bread.
6. Could this bread be sold with a whole grain stamp on the label? How much whole grain is in each slice/serving?

Learn more about the Whole Grain Stamp used on grain food labels, ***wholegrainscouncil.org/whole-grain-stamp***

7. Evaluate any breads with less than okay results, using p. 18.

Pilgrim Bread

Yield: 2 loaves Preparation Time: 2 hours (may be divided) Baking Time: 30 minutes Dough Weight:_____

Ingredients	Measurement	Weight	Bakers %
Water, boiling	1 3/4 cups	14 oz	_____
Cornmeal or enriched whole grain	½ cup	2.5 oz/70g	_____
Water, 105° F.	¼ cup	4 oz	_____
Active dry yeast	2 ¼ teaspoons	¼ oz/7g	_____
Sugar	1 teaspoon	4g	_____
Brown sugar	¼ cup	3.75 oz/100g	_____
Whole wheat flour	3 ½ cups	14 oz/400g	_____
Rye flour, whole grain	½ cup	1.8 oz/100g	_____
Butter or vegetable oil	¼ cup	2 oz/55g	_____
Salt	2 ½ teaspoons	1/2 oz/15g	_____
Bread flour	2 cups	8.5 oz/235g	_____

Nutrition Facts

Serving Size (40g)
Servings Per Container

Amount Per Serving

Calories 100 Calories from Fat 15

	% Daily Value*
Total Fat 2g	3%
Saturated Fat 0g	0%
Trans Fat 0g	
Cholesterol 0mg	0%
Sodium 170mg	7%
Total Carbohydrate 18g	6%
Dietary Fiber 2g	8%
Sugars 2g	
Protein 3g	

Vitamin A 0% • Vitamin C 0%
Calcium 0% • Iron 6%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

		Calories: 2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300 mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

Directions: Day One (50 minutes)

1. In a mixing bowl, whisk together the boiling water and cornmeal. Let cool to 85° F.
2. Combine ½ cup warm water, 1 teaspoon sugar and active dry yeast, whisking to combine. Allow to proof for 5-10 minutes—mixture should foam up.
3. Mix into the cornmeal mixture the brown sugar, whole wheat flour, rye flour, butter or oil. Take temperature: When 105° F. or cooler, add yeast mixture, salt and bread flour. Mix for three minutes—the dough should form a shaggy rough dough that is not wet, but still moist.
4. Begin kneading (or use mixer's dough hook). If kneading by hand, use small flour sprinkles and knead until dough is smooth, moist and elastic (7-10 minutes)*. On the mixer, mix until dough cleans the bowl and begins to slap the sides, about 7-9 minutes. The dough should be moist, smooth and elastic. If dough is firm or dry, knead in water sprinkles, adding 1-2 tablespoons as you knead or mix.
5. Form a rounded dough ball, place in an oiled or sprayed large plastic food bag or bowl, turning the dough so the smooth, oiled side is up. Cover bowl OR squeeze air out of bag and twist tie the bag at the top. Let raise (ferment) until double (about 40 minutes) or place in refrigerator to ferment one hour to overnight. Note step 6.
6. When dough doubles in size, deflated gently; fold dough into middle and turn to form smooth ball. Turn smooth side up. Keep refrigerated until ready to shape, or go to Day 2, Step 2.

Directions: Day Two (60 minutes)

1. Take dough out of refrigeration an hour before shaping and proofing (raising) for baking.
2. Gently divide raised dough. Weigh or scale dough to have two equal dough pieces. Shape two loaves (round, or for 8 ½ x 4 ½-inch pan).
3. Place shaped loaves in greased loaf pans or on parchment-lined sheet pan(s). Cover loosely with oiled or pan-sprayed plastic wrap lightly laid on top of dough.
4. Proof ("raise") loaves covered, until doubled in volume, in warm (95°-105° F.) draft-free place, about 30 minutes. Round loaves: cut an X, about 1/4 inch deep in center before baking.
5. Preheat oven: 360° F. Bake loaves 25-30 minutes—until internal temperature is 200°-210° F.
6. Cool bread on wire cooling rack; slice or wrap when bread cools to 90-100° F. interior temperature.
7. Freeze within one day if not eaten, or store at room temperature (70°-90°F.).

DIY Test Kitchen: CinnaRaisin Bread: Increase sugar to 1/2 cup and mix with 1 teaspoon cinnamon before adding to dough. Knead or press in 2 cups moist raisins at the end of the kneading time. Makes 2 loaves or 24 large buns. More great raisin breads at *loveyourraisins.com.*

***Hand-Kneading Tip:** After about 250 (3-5 minutes) turns of kneading, cover dough on counter with bowl and take a break, clean area; return and knead another 2-4 minutes.

Local Connection:
Add-a-Whole Grain Signature Bread

- Have students meet with a local food provider (the client) – school cafeteria, emergency shelter, after school program, food pantry, or family – to add a whole grain bread to their menu.

Bring student-approved breads from lab for them to choose a sample whole grain bread to try with their clientele.

- Use *A Matter of Taste* form for customers' responses to the bread product samples.
- Tally the results. Consumer approval ratings of over 60% in a category means it will "sell" well in that category with the clientele. Less than a 60% ranking in a category means some adjustments need to be made to improve that part of the product.
- Discuss adjustments that could be made, make the adjustments, re-test. Provide the client with this winning whole grain formula (recipe) when the product reaches 60% or above approval for their food baskets or to include on future menus.
- **EXTRA!** At an after-school program, you may wish to also share a favorite story such as *Everybody Bakes Bread* by Norah Dooley. Ask students to prepare a "Food Network" bread demonstration and invite participants to help make and take the bread.

Need a whole grain bread that doesn't seem like whole grain? Best Ever Cornbread works!

- How? Use either whole grain cornmeal OR whole white wheat flour to make a golden cornbread customers will accept.
- Whole grain = 51% or more of the grain ingredients are whole grain.
- Cut and serve small sample squares with a drizzle of honey – 1 pan = 50 samples.

Want a demo? View DIY Baking Channel Cornbread video, ***HomeBaking.org*** OR Baking for Success DVD, Cornbread.

Check out Martha's Tips and Southern Cooking Tips at *marthawhite.com/about-cooking/southern-cooking*

Best-Ever Cornbread

Preparation time: 10 minutes Baking time: 18 minutes (muffins), 30 minutes (cornbread)
Makes 12 (1.8 oz/ 50g) squares, muffins or wedges

Ingredients	Measurement	Weight
All-purpose flour or Ultragrain® flour*	1 cup	4 oz/ 115g
Whole cornmeal, yellow or white	1 cup	4.875 oz/ 140g
Granulated sugar (optional)	2 tablespoons	0.875 oz/ 25g
Baking powder	1 tablespoon	0.375 oz/ 10g
Salt	½ teaspoon	0.16oz/ 4g
Large eggs	2	3.5 oz/ 100g
Melted butter or oil	¼ cup	2 oz/ 45g
Milk	1 cup	8 oz/ 250ml

**Or ½ cup whole white wheat flour and ½ cup all-purpose flour*

Photo courtesy of HodgsonMill.com

Directions

1. Preheat oven to 425° F.
2. Grease bottom and sides of a 9-inch square or round baking pan, cast iron skillet or 12 medium muffin cups.
3. In a medium-sized bowl, mix together the dry ingredients; flour, cornmeal optional sugar, baking powder, salt.
4. In a separate bowl or large measuring cup mix well the eggs, butter and milk.
5. Add the egg mixture to the dry ingredients and mix only until dry ingredients are combined. Do not over mix; the batter will not be smooth.
6. Pour batter into the greased pan or fill greased muffin cups 2/3 full. Bake until golden, cornbread 25 to 30 minutes (toothpick inserted will come out without batter); muffins 18-20 minutes.
7. Serve warm, drizzling with honey or honey butter (blend 3 tablespoons honey + 1 stick butter).

Nutrition Facts: One square or muffin (1.8 oz/ 50g) provides: Calories 130; Total Carbohydrates 19g; Sugars 3g; Protein 4g; Fat 6g; Fiber 2g; 10g Whole Grain (½ serving); Sodium 210mg; Potassium 154mg; Cholesterol 36mg

What Happened to the Yeast Bread?

Yeast Bread Problem	What Could Have Happened to Cause It?	
Too much volume	• Too much yeast • Oven temperature too low • Wrong kind of flour for the bread recipe	• Too little salt • Overproofed • Too much dough for the baking pan
Too little volume	• Too little yeast or old yeast • Dough chilled • Over or underproofed • Kneaded too much or not enough	• Too much salt • Wrong kind of flour for the bread recipe • Not enough dough in the baking pan
Pale color	• Not enough sugar • Overfermented dough	• Oven temperature too low • Dried crust formed before baking
Dark color	• Too much sugar • Dough temperature too low • Baked too long	• Too much milk • Oven temperature too high
Cracked rust	• Overmixed • Improperly shaped • Top of hard-crust bread not slashed properly before baking	• Dough too stiff • Cooled too fast • Dried crust formed during proofing
Blisters on crust	• Too much liquid	• Improperly shaped
Coarse texture	• Not enough flour • Underkneaded • Temperature of dough out of mixer too high	• Slack dough • Proofed too long or at too high a temperature
Large holes in bread	• Too much yeast • Inadequate punch down	• Overkneaded
Heavy texture	• Underkneaded • Not enough yeast • Too short proofing time • Too much dough in the baking pan	• Too cool proofing temperature • Poor distribution of ingredients • Yeast partially killed by hot liquid
Crumbly, dry	• Too stiff dough • Dough proofed too long	• Under-kneaded • Oven temperature too low
Poor flavor	• Flat flavor – too little salt • Sour flavor – too long proofing or poor quality ingredients	• Yeasty flavor – too long proofing period or proofing temperature too warm
Poor oven spring	• Over-proofed (use "ripe" test) • Environment too hot for proofing	• Use finger "ripe" test to determine if proofed enough/ready to bake: press the tips of 2 fingers lightly and quickly about 1/2-inch. If the indention remains it has raised enough. (see picture in Glossary)
Bread falls in oven	• Dough over-proofed • Oven not heated/turned off	• Flour too weak or low in protein
Collapsed Loaf	• Salt omitted, causing bread to overrise and then collapse • Liquid/dry ratio not balanced • Dough exceeds pan capacity, does not bake through and collapses. • Warm weather and high humidity may cause dough to rise too fast, then collapse before baking begins. • Too much yeast, causing over-rising and collapsing.	