

Grain Science

Lesson 3: Milling



Unit:	Grain Science
Estimated Time:	50 Minutes
Age of Learners:	9th-12th Grade

Equipment, Supplies, References, and Other Resources:

- Go Get It cards
- Milling Process video: https://www.youtube.com/watch?v=3Zli8HiQ_VQ&t=75s
- Milling Process worksheet
- Milling Process PowerPoint
- Flour Mill iVisit: <https://my.matterport.com/show/?m=ignwTYmpPC7>
- Coffee grinder or mill
- Tempered wheat (from Day 2)
- Untempered wheat

Instructor Directions & Estimated Time	Content Outline and/or Procedures
<p>Objectives</p>	<ol style="list-style-type: none"> Describe the parts of a wheat seed, including the bran, endosperm, and germ, and understand their respective roles in the milling process. Analyze the complete process of milling grains into flour, including cleaning, tempering, and grinding, by examining the steps involved and their significance in producing high-quality flour products. Evaluate the various systems and equipment used in the milling process, such as the breaker system, purification system, and reduction system, by observing visual representations and videos to understand their functions and contributions to flour production. Apply knowledge of the milling process by grinding both tempered and untempered wheat samples and observing the characteristics of the resulting flour, as well as summarizing the three main steps of milling wheat in concise terms.
<p>Feed the Sourdough</p> <p>~3 minutes</p> <p><i>Only one student needs to feed the class starter.</i></p>	<ul style="list-style-type: none"> Start feeding by removing the starter from the container. In a bowl, mix 1 cup (115 grams) flour and 1/2 cup (115 grams) water with the starter, mixing by hand until smooth. Clean original container before replacing the starter. Cover and store.
<p>Milling Go-Get-It</p> <p>~ 3 minutes</p> <p><i>Place the 14 cards or pieces of paper around the room with the terms and definitions. When instructed to do so, students will find a card and then try to find the person who has the card with the corresponding term or definition.</i></p>	<p>Milling – process of cleaning, tempering, and grinding cereal grains into flour and other milled grain products</p> <p>Bran – the outermost layer of the seed</p> <p>Endosperm – largest part of the seed that provides food to the germ</p> <p>Germ – the embryo of the wheat plant</p> <p>Sizing – endosperm particles size in the range 210-500 micrometers</p> <p>Middling – endosperm particles 150-210 micrometers</p> <p>Purification – purifies or cleans coarse endosperm by removing bran and germ</p>
<p>Milling Process Video</p> <p>~ 3 minutes</p> <p><i>Show this video (also linked on the first slide) which describes the process of wheat from shipping to milling and blending.</i></p> <p>https://www.youtube.com/watch?v=3Zli8HIQ_VQ&t=75s</p>	<p>As you watch, listen for the terms and processes you learned about from the previous lesson about tempering and cleaning and discover how they are tied into the milling process.</p> <p>At the end of the video, ask students to discuss two things they learned with a partner.</p>

Instructor Directions & Estimated Time	Content Outline and/or Procedures
<p>Milling Process – Worksheet</p> <p>~ 3 minutes</p> <p><i>Students will read this worksheet before discussing the milling process on the slides. Students can read this individually or with a partner. Encourage students to underline words that are new to them.</i></p>	<p>Before understanding the process of milling, it is important to know the parts of a wheat seed.</p> <p>The bran is the outermost layer of the seed, also called the kernel. It constitutes 14.5 percent of the seed weight and contains fiber. The endosperm is the largest part of the seed comprising 83 percent of the kernel weight. Providing nutrients to the embryo, it contains starchy carbohydrates, protein, iron and B-vitamins. The germ is the embryo of the wheat plant. It makes up 2.5 percent of the seed weight. The germ contains fat, protein, minerals, and fiber.</p> <p>The complete process of milling is cleaning, tempering, and grinding grains into flour and other grain products. The final phase of grinding wheat into flour is completed in three main steps.</p> <p>The first is the break system where wheat is ground by two rollers rotating toward each other at different speeds. In this step, the wheat kernel is opened, and the endosperm is scraped from the bran. The bran is kept in as large of pieces as possible. The goal is to keep small bran pieces and bran powder to a minimum.</p> <p>The next step is the purification system where the bran and germ pieces are separated from the endosperm to create sizings through a process of sieving and air current. The coarse chunks of endosperm particles are reduced in size, removed, and sent to the next step.</p> <p>The final step is middlings reduction which is accomplished through sifting. Middlings are the large and small particles of bran, germ, and flour remnants. This step reduces purified middlings into high-quality flour with minimal bran and germ contamination. To accomplish this, the action is to grind and sift, grind and sift, and repeat.</p>

Instructor Directions & Estimated Time	Content Outline and/or Procedures
<p>Milling Process Slides</p> <p>~ 10 minutes</p> <p><i>After students finish reading, continue discussing the milling process by showing and discussing the slides.</i></p>	<p>Now we'll take a closer look at milling.</p> <p>Slide 2: Grind and sift, grind and sift, grind and sift, grind and sift</p> <p>Breaker (rollers) → Purification (sift) → Reduction (Sift)</p> <p>Repeat!</p> <p>Slide 3: Break System (Grind)</p> <p>The following occurs in a roller mill:</p> <ul style="list-style-type: none"> • opens the wheat kernel • scrapes the endosperm from the bran • keeps the bran in as large of pieces as possible, keeping small bran pieces and bran powder to a minimum. <p>Slide 4: Roller Mill images</p> <p>Slide 5: Purification System (First step in sifting)</p> <p>The following occurs in a purifier:</p> <ul style="list-style-type: none"> • removes impurities • removes smaller bran pieces • reduces coarse chunks of endosperm to fine, equally sized particles (sizings) (referred to as semolina in this video, which is made from durum wheat) • https://www.youtube.com/watch?v=JmyhXxz4OmU (stop at 1:40) <p>Slide 6: Reduction System (sift)</p> <p>The following occurs with a sifter:</p> <ul style="list-style-type: none"> • reduce purified large coarse particles (middlings) into flour with the least amount of bran and germ contamination • https://www.youtube.com/watch?v=A2B_7RmpF60 (:56) no narration on this video – just a visual of the sifting. <p>Particles from this reduction system go back to the roller mill to start the grinding and sifting process over!</p> <p>Slide 7: Sifter images</p> <p>Slide 8: Flour Mill iVisit</p>
<p>Flour Mill iVisit</p> <p>~5 minutes</p> <p><i>When finished presenting the slides, students will explore the Hal Ross Flour Mill using this link:</i></p> <p>https://my.matterport.com/show/?m=ignwTYmpPC7</p>	<p>Over the next five minutes, you will use your device to explore the Hal Ross Flour Mill. Look for the equipment we discussed in the slides and on the worksheet.</p> <p>What are your take-aways from the flour mill?</p> <p><i>Possible responses:</i></p> <ul style="list-style-type: none"> • <i>it is tall (this allows for the use of gravity to move wheat from the top to the bottom)</i> • <i>it is clean (important for safety of the workers; prevents explosions)</i>

Instructor Directions & Estimated Time	Content Outline and/or Procedures
<p>Grinding</p> <p>~ 20 minutes</p> <p><i>Use a coffee grinder for this activity if you do not have a mill.</i></p> <p><i>Students will do a “light” mill and identify sizings (large granules, also called semolina) and middlings (larger than sizings and contain endosperm and bran). Compare and contrast tempered wheat and untampered wheat.</i></p>	<p>Grind tempered and untempered wheat from previous lesson.</p> <ol style="list-style-type: none"> 1. Grind dry wheat and observe characteristics of flour 2. Grind tempered wheat and observe characteristics of flour <ol style="list-style-type: none"> a. Wheat tempered for 15 minutes b. Wheat tempered for 24 hours
<p>Exit Ticket</p> <p>~ 3 minutes</p> <p><i>Distribute note cards to students.</i></p>	<ul style="list-style-type: none"> • Using your worksheet and what we discussed in class today, list the three main steps in milling wheat with no more than five words to describe each.

	State Standards
<p>Language Arts</p>	<ul style="list-style-type: none"> • RI.9-10.4. Determine the meaning of words and phrases as they are used in a text, including figurative, connotative and technical meanings; analyze the cumulative impact of specific word choices on meaning and tone. • RI.9-10.11.d. Verify the preliminary determination of the meaning of a word or phrase. • SL.11-12.1. Initiate and participate effectively in a range of collaborative discussion (one-on-one, in groups and teacher-led) with diverse partners on grades 11-12 topics, texts and issues, building on others’ ideas and expressing their own clearly and persuasively.
<p>Science</p>	<ul style="list-style-type: none"> • HSL3-3. Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). • HS-LS1-2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. • HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
<p>Math</p>	<ul style="list-style-type: none"> • F.LQE.1c. (11). Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another. • N.Q.2. (all). Define appropriate quantities for the purpose of descriptive modeling. • MP.2. Reason abstractly and qualitatively.

Resources:

NAMA – <https://namamillers.org/consumer-resources/what-is-milling/>

1. <https://www.youtube.com/watch?v=AApBAiscP4o> OR <https://www.youtube.com/watch?v=WOmJ-Se7PKM> OR <https://www.youtube.com/watch?v=PvnW7qHNmmo> OR

Lesson 3: Milling Worksheet

Go-Get-It Cards

Milling

Bran

Endosperm

Germ

Sizing

Middling

Purification

**process of cleaning,
tempering, and
grinding cereal grains
into flour and other
milled grain products**

**the outermost layer of
the seed**

**largest part of the seed
that provides food to
the germ**

**the embryo of the
wheat plant**

**endosperm particles
size in the range 210-
500 micrometer**

**endosperm particles
150-210 micrometers**

**purifies or cleans
coarse endosperm by
removing bran and
germ**

Grain Science

Lesson 3: Milling Worksheet

Milling

Grinding grain can be traced back thousands of years to the fertile crescent. Large stones were used to grind grain for food in ancient Mesopotamia. Water mills followed in Asia in 85 B.C. and windmills were used in Europe one thousand years later. Today grain is still grinded to make flour and the process is called milling. Milling is the process of cleaning, tempering, and grinding cereal grains into flour and other milled grain products.

Parts of the Wheat Seed

Before understanding the process of milling, it is important to know the parts of a wheat seed.

The bran is the outermost layer of the seed, also called the kernel. It constitutes 14.5 percent of the seed weight and contains fiber. The endosperm is the largest part of the seed comprising 83 percent of the kernel weight. Providing nutrients to the embryo, it contains starchy carbohydrates, protein, iron and B-vitamins. The germ is the embryo of the wheat plant. It makes up 2.5 percent of the seed weight. The germ contains fat, protein, minerals, and fiber.

Steps of the Milling Process

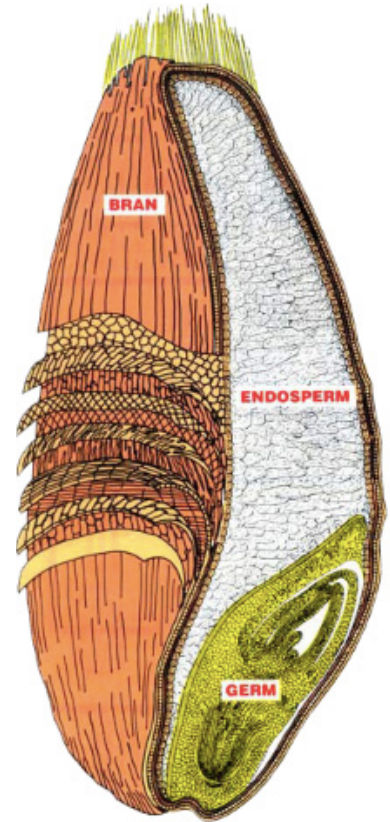
Milling wheat into flour is completed in three main steps. The first is the break system where wheat is grinded by two rollers rotating toward each other at different speeds. In this step, the wheat kernel is opened, and the endosperm is scraped from the bran. The bran is kept in as large of pieces as possible. The goal is to keep small bran pieces and bran powder to a minimum.

The next step is the purification system where the bran and germ pieces are separated from the endosperm to create sizings through a process of sieving and air current. The coarse chunks of endosperm particles are reduced in size, removed, and sent to the next step.

The final step is middlings reduction which is accomplished through sifting. Middlings are the large and small particles of bran, germ, and four remnants. This step reduces purified middlings into high-quality flour with minimal bran and germ contamination. To accomplish this, the action is to grind and sift, grind and sift and repeat.

Grinding

You will grind the wheat samples that were cleaned from the previous lesson.



1. Place ½ cup of cleaned wheat in grinder. Grind the wheat for 5 seconds.
2. Remove the kernels from the grinder and spread out on a plate. Record your observations in Table 1.
3. Repeat this step 2 more times.
4. After you have grinded the wheat three times and recorded your observations, grind it until it turns into a flour consistency.

Table 1. Observations

	Record your observations of the wheat kernels after each grind in the space below. Did the kernel open, were there smaller bran pieces, coarse chunks of endosperm, flour, etc.?
Grind 1	
Grind 2	
Grind 3	

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Grain Science lessons are posted at:
<https://www.grains.k-state.edu/educator-resources/untitled.html>

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