



National Agriculture in the Classroom

Relevancy and Engagement: agclassroom.org

Get Popping!

Grade Level(s)

3 - 5

Estimated Time

2 hours

Purpose

Students will discover how popcorn is grown and explore the phenomenon of how popcorn pops.

Materials

Interest Approach – Engagement

- Popcorn cob in a brown paper bag*, Jiffy Pop popcorn, or a bag of microwave popcorn
- Hot plate or microwave
- Un-popped popcorn kernels, 1 per student
- Popped popcorn, 1 piece per student

*These items are included in the [Popcorn on the Cob! Kit](#), which is available for purchase from agclassroomstore.com.

Activity 1:

- Un-popped popcorn kernel, 1 per student
- Popped popcorn, 1 piece per student
- *Before, During, After* graphic organizer
- *Popcorn: Where Does It Come From and What is It Made Of?* PowerPoint (optional)
- From [Seed to Snack](#) page on the popcorn.org website (optional)
- [How It's Made: Popcorn](#) video (optional)

Activity 2:

- Safety glasses*
- 2 test tubes*
- Small balloon*
- Test tube clamp*
- Alcohol lamp*
- Denatured alcohol (fuel for the alcohol lamp)
- Multi-purpose lighter
- Vegetable oil*, 1 drop
- Un-popped popcorn kernel*
- Aluminum foil*
- Circle-shaped sticky notes or circle-shaped paper die-cuts, 8 per group
- Playdough, 1 handful per student
- [Popping Popcorn in Ultra Slow Motion](#) video

*These items are included in the [Get Popping! Kit](#), which is available for purchase from agclassroomstore.com.

Activity 3:

- Nutrition labels from various snack foods
- Air-popped popcorn, 3 cups

- Stick of butter

Essential Files (maps, charts, pictures, or documents)

- Popcorn: Where Does it Come From and What is It Made Of? PowerPoint
[<https://naitec-api.usu.edu/media/uploads/2018/02/02/Popcorn.pptx>]
- Before, During, After Graphic Organizer
[https://naitec-api.usu.edu/media/uploads/2018/01/29/Before_During_After.pdf]

Essential Links

- How It's Made: Popcorn
[<http://www.popcorn.org/Facts-Fun/From-Seed-to-Snack>]
- From Seed to Snack Webpage
[<http://www.popcorn.org/Facts-Fun/From-Seed-to-Snack>]
- Popping Popcorn in Ultra Slow Motion Video
[<https://www.youtube.com/watch?v=FSZd33awqQk>]

Vocabulary

Corn Belt: the area of the United States where corn is the predominate crop grown

combine: a machine that cuts crops (such as corn or wheat) and separates the seeds of the plant from the rest of the plant

endosperm: tissue formed within a seed that contains energy (starch) and protein for the germinating seed

germ: the living embryo of the corn kernel that contains the essential genetic information, enzymes, vitamins, and minerals for the kernel to grow into a corn plant

germinate: to begin to grow; sprout

grain: the edible seed or seed-like fruit of grasses that are cereals

pericarp: the outer, protective covering of the corn kernel

pollination: the transfer of pollen

whole grain: contains the entire grain kernel

Interest Approach – Engagement

1. Show the class the popcorn cob. Ask them if they know what kind of corn it is? (If you do not have a popcorn cob, show the class a container of Jiffy Pop popcorn or a bag of microwave popcorn. Ask the students what they think is inside the packaging.)
2. Give each student an un-popped popcorn kernel to observe.
3. With your students, pop popcorn right off the cob. Place the cob in a paper bag, fold the top of the bag down twice to secure the top, place in the center of a microwave, and heat on high power for 1-1/2 to 3-1/2 minutes (time will vary with the wattage of the unit). Stop the microwave when fast popping slows to 1-2 seconds between popping. Carefully open the bag. The cob is very HOT! Note: some kernels may not pop due to uneven heat distribution in the microwave. (If you are popping Jiffy Pop over a hot plate or microwave popcorn, follow the directions on the packaging.)
4. Ask the students to describe what they observe. Discuss the steam that is present the moment the bag is opened.
5. Give each student a piece of the popped popcorn to observe. Ask the students what differences they observe between the un-popped and popped popcorn.
6. Ask the students, "How does popcorn pop?" After hearing their responses, let them know that this is a phenomenon worth investigating.



Did you know? (Ag Facts)

- Popcorn can pop as high as 3 feet in the air.¹
- The peak period for home consumption popcorn sales is in the fall.¹
- Popping popcorn is one of the most common uses for microwave ovens. Most microwave ovens have a "popcorn" control button.¹

Background - Agricultural Connections

Popcorn is a "New World" food—it originated in the Americas and was unknown in the Eastern continents until after the voyage of Columbus. Just because it's called a "New World" food doesn't mean it's very new at all. In fact, the oldest ears of popcorn ever found were discovered at Bat Cave in west central New Mexico and are thought to be around 5,600 years old.² Native tribes from North and South America relied on popcorn as an important food staple but also used it as a decoration. Cortez noted this in 1519 when he came into contact with the Aztecs, who used it to create exquisite decorations like ceremonial headdresses, necklaces, and ornaments on statues.

Americans today consume 13 billion quarts of popcorn each year, more than any country in the world.³ 13 billion quarts averages out to about 42 quarts (40 L) or 10.5 gallons per person. Imagine 10.5 gallon milk containers full of popcorn for every person in the United States. That's a lot of popcorn! The majority of the popcorn consumed worldwide is grown in the **Corn Belt** of the United States covering Iowa, Illinois, Indiana, southern Michigan, western Ohio, eastern Nebraska, eastern Kansas, southern Minnesota, and Missouri. Nebraska is the top producer of popcorn.

Popcorn is a type of maize (corn) scientifically known as *Sea mays everta*. There are five different types of corn—sweet corn, popcorn, dent (field) corn, flour corn, and flint corn—but only one kind that pops...popcorn! Popcorn seeds are planted in the spring and take 7-10 days to **germinate**. The plant can grow to about 8 feet high and produce ears of corn covered in a green husk. Popcorn plants are wind **pollinated**. The pollen is located in the tassels at the top of the plant. The ears form silks that catch the pollen as the wind blows. The pollen travels down a small tube in each silk and fertilizes the ovule at the base. After successful fertilization, a kernel develops and the silk detaches.

The popcorn is ready to harvest when the kernels become hard and the stalk and leaves of the plant are brown and dry. Typically, a **combine** is used to harvest the popcorn. The ears are stripped from the stalk, and the kernels are shelled from the cob in the combine. The kernels are transported to a storage bin where they are dried until they reach the ideal moisture level of 14%. The kernels are then cleaned, polished, and packaged for distribution.

Popcorn is a **grain** composed of three parts—the **pericarp** (hull), **germ**, and **endosperm**. The pericarp is the hard outer shell surrounding the popcorn kernel. Inside the kernel is the germ, or seed embryo, and the endosperm. The endosperm contains trapped water and starch, which serves as food for the embryo during germination.

The popcorn kernel will pop when it is heated to an internal temperature of 400-460°F (204-238°C). When the kernel is heated, the moisture in the endosperm begins to boil and turns to steam. Because the pericarp is hard, pressure builds up inside the kernel. The starch gelatinizes and the moisture vaporizes until the pressure inside the kernel reaches 135 pounds per square inch. At this point the kernel bursts open and the starch solidifies to form the white, puffy part of popped popcorn. As the kernel turns inside out, the steam escapes.

One serving of popcorn provides about 70% of the recommended individual daily intake of **whole grains**. Popcorn also contains fiber, iron, and a number of essential vitamins. Per cup, popcorn contains 31 calories when air-popped, 55 calories when oil-popped, and 133 calories when lightly buttered. Popcorn is a healthy and nutritious whole grain snack option.

Procedures



This lesson investigates the phenomenon of popcorn popping. Natural phenomena are observable events that occur in the universe that we can use our science knowledge to explain or predict.

Phenomenon-Based Episode: How Does Popcorn Pop?

Disciplinary Core Ideas: [Structures and Properties of Matter](#)

National Agricultural Literacy Outcome Theme: [Food, Health, and Lifestyle](#)

Question	Science and Engineering Practices	Student Engagement in Practices	Explanation
1. What is a popcorn kernel made up of?	<ul style="list-style-type: none"> Obtaining, Evaluating, and Communicating Information 	Students obtain, evaluate, and communicate information about the parts of a popcorn kernel.	A popcorn kernel is comprised of three parts—the pericarp, germ, and endosperm. The pericarp is the hard, outer shell surrounding the kernel. Inside the kernel is the germ, or seed embryo, and the endosperm. The endosperm contains trapped water and starch.
2. What happens to water when it is heated?	<ul style="list-style-type: none"> Planning and Carrying Out Investigations Developing and Using Models 	Students carry out investigations and develop models to explore what happens to water when it is heated.	As water is heated and reaches the boiling point, it changes from a liquid to a gas (steam). The molecules in the steam move apart and take up any available space.
3. What happens to the water inside a popcorn kernel when the kernel is heated?	<ul style="list-style-type: none"> Planning and Carrying Out Investigations Engaging in Argument from Evidence 	Students carry out investigations and engage in argument from evidence to explore and explain what happens to the water inside a popcorn kernel when the kernel is heated.	As the kernel heats up, the water inside boils and turns into steam. Because the pericarp is hard, pressure from the steam builds up inside the kernel. The pressure eventually becomes so great that the kernel bursts open.
4. How does popcorn pop?	<ul style="list-style-type: none"> Engaging in Argument from Evidence Constructing Explanations and Designing Solutions 	Students engage in argument from evidence and construct explanations to describe how popcorn pops.	As the kernel heats up, the water inside boils and turns into steam. Because the pericarp is hard, pressure from the steam builds up inside the kernel. The starch gelatinizes and the pressure eventually becomes so great that the kernel bursts open, and the starch solidifies to form the white, puffy part of the popcorn.

Activity 1: Anatomy of a Popcorn Kernel (Episode Question 1)

1. Organize the students into small groups. Have the students bring their un-popped and popped popcorn from the *Interest Approach – Engagement* to their groups. Provide each student with a copy of the *Before, During, After* graphic organizer.
2. Ask the students to discuss the following question with their group, "What do you think happens to popcorn before, during, and after popping?"
3. Instruct the students to record their ideas in the appropriate sections of the graphic organizer. Allow time for each group to share their ideas with the class.
4. Explain to the students that in order to understand how popcorn pops, it is helpful to know more about the parts of a popcorn kernel, how it is grown, and how it differs from other types of corn.
5. Choose from the following options to examine how popcorn is grown and the parts of a popcorn kernel.
 - Review the *Popcorn: Where Does it Come From and What's it Made Of?* PowerPoint.
 - Explore the [From Seed to Snack](#) page on popcorn.org.
 - View the [How It's Made: Popcorn](#) video.

6. Place the students back into their groups, and allow time for them to add to, revise, and/or question their original ideas on their graphic organizer. Share any additions, revisions, or questions with the whole group.

Three Dimensional Learning Proficiency: Crosscutting Concepts

Students link different domains of science fields into a coherent and scientifically-based view of the world.

- Structure and Function: [The way an object is shaped or structured determines many of its properties and functions.](#)

Activity 2: Exploring How Popcorn Pops (Episode Questions 2-4)

Safety Notes: The following safety procedures should be practiced when performing the investigations in *Activity 2*:

- Roll up long sleeves
 - Tie back long hair
 - Wear safety glasses
 - Keep work area clear
 - Keep the test tube opening pointed away from yourself and students
1. Students should have observed steam as part of the *Interest Approach – Engagement* activity. Ask the students, "How is steam created?" (*Steam is created when water is heated and liquid changes to gas—water vapor. When water vapor meets the colder air, it condenses into tiny water droplets suspended in air—steam.*)
 2. Ask the students to consider how to design an experiment to observe water changing to steam using a test tube, water, a balloon, and a heat source. Discuss their ideas and guide the class until they come up with a procedure similar to the following.
 3. Put on safety glasses. Fill a test tube **half-way** with water. (To avoid boiling water entering the balloon and spraying out when the balloon pops, do not fill the test tube more than half-way. If boiling water begins to enter the balloon, immediately remove the test tube from the heat.) Stretch out a small balloon by blowing it up a few times, and then stretch the balloon opening over the top of the test tube, pulling the balloon down over the top one inch of the tube. Use a test tube clamp to hold the test tube over the flame of an alcohol lamp. Ask the students to predict what they think will happen as the water heats up.
 4. As the water reaches the boiling point, ask the students, "What are you observing?" (*The water is changing to steam. The steam is expanding and trying to escape, inflating the balloon with its pressure.*) Ask the students to predict what they think will happen to the balloon and why. (*Eventually, the steam will create enough pressure to explode the balloon.*) It will take about 3 minutes for the balloon to inflate and about 6 minutes for the balloon to pop.



5. Ask the students to diagram what they observed. Use the student diagrams to explain that all matter is made up of tiny parts called molecules. The arrangement of molecules differs in solids, liquids, and gases.
6. Model the arrangement of molecules in solids, liquids, and gases using one of the following options.
 - Have the students make fists with their hands, and push their fists tight together to demonstrate that the molecules in solids are tight together. Have the students rub their fists lightly together to demonstrate that molecules in liquids stick together, but can move around. Ask the students to think about what the steam was doing inside the balloon, and use their fists to demonstrate molecules in gases. The students should move their fists all over the place to demonstrate that molecules in gases move apart and take up any available space.
 - Place students in small groups and provide each group with 8 circle sticky notes. Have the students arrange the sticky notes so that they are touching each other tightly together to demonstrate that the molecules in solids are tight together. Have the students arrange the sticky notes so that they are lightly touching each other to demonstrate that molecules in liquids stick together, but can move around. Ask the students to think about what the steam was doing inside the balloon, and use the sticky notes to demonstrate molecules in gases. The groups should arrange the sticky notes so that they are not touching each other and taking up as much space as possible on the desk to demonstrate that molecules in gases move apart and take up any available space.
 - Provide each student with a handful of playdough. Ask the students to make 8 small balls of dough. Have the students arrange the playdough balls so that they are touching each other tightly to demonstrate that the molecules in solids are tight together. Have the students arrange the playdough balls so that they are lightly touching each other to demonstrate that molecules in liquids stick together, but can move around. Ask the students to think about what the steam was doing inside the balloon, and use the play dough balls to demonstrate molecules in gases. The students should arrange the playdough balls so that they are not touching each other and taking up as much room as possible on the desk to demonstrate that molecules in gases move apart and take up any available space.
7. After modeling the molecules in solids, liquids, and gases, ask the students to explain how the steam made the the balloon expand and eventually burst. (*As the water was heated and changed from liquid to gas (steam), the molecules in the steam moved apart to take up any available space, filling up the balloon and eventually causing enough pressure to burst it.*)
8. Review the parts of a popcorn kernel, and remind the students that popcorn kernels contain water. Ask them to predict and explain what will happen if a kernel of popcorn is heated in a test tube.
9. After hearing the predictions and explanations, put on safety glasses, place one kernel of popcorn and a drop of vegetable oil in a dry test tube, and cover the top of the test tube with aluminum foil. Use a test tube clamp to hold the test tube over the alcohol lamp flame. Shake the test tube to avoid burning the kernel. (Keep the top of the test tube pointed away from you and the students!) It will take about 1 minute for the kernel to pop.
10. To view popcorn popping in slow motion, show the class the [Popping Popcorn in Ultra Slow Motion](#) video.



11. Clarify that each kernel of popcorn contains water stored inside a circle of soft starch. Ask the students to explain what they observed. (*As the kernel heats up, the water inside the kernel boils and turns into steam. Because the pericarp is hard, pressure from the steam builds up inside the kernel. The starch gelatinizes and the pressure eventually becomes so great that the kernel bursts open and the starch solidifies to form the white, puffy part of the popcorn.*)
12. Ask the students to use their fists to demonstrate the water molecules inside the popcorn kernel, and then the steam molecules when the kernel was heated.
13. Place the students back into their groups from *Activity 1*, and allow time for them to add to, revise, and/or question their original ideas on their graphic organizer. Share any additions, revisions, or questions with the whole group. Ask the students to share how their thinking changed and why. Use the completed graphic organizers to evaluate student understanding.



If you put a cob of sweet corn in a microwave, will the kernels pop like popcorn? It's important to understand that different corn varieties are grown to meet various food and production needs. There are five different types of corn—dent corn, sweet corn, popcorn, flour corn, and flint corn—but only one kind that pops...popcorn! Sweet corn will not pop because, unlike popcorn, the kernels do not have a hard pericarp or the ideal moisture level inside. See the lesson [Corn an Amazing Plant: Food, Fuel, and Plastic](#) for more information about the different varieties of corn.



Three Dimensional Learning Proficiency: Crosscutting Concepts

Students link different domains of science fields into a coherent and scientifically-based view of the world.

- Cause and Effect: [Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.](#)

Activity 3: Popcorn Nutrition

- Have the students bring in nutrition labels from their favorite snacks. Compare and contrast calories, fat, sugar, and vitamin content. Line the labels up in order of calorie content. Reorganize the labels in order of sugar content. Repeat with fat content. Ask the students to determine which snack food is healthiest overall.
- Put three cups of air-popped popcorn into a bowl, show it to students, and write the calorie content (93 calories) on the board.
- Hold up a stick of butter and write the calorie content (810 calories) on the board. Ask the students, "If you added one stick of butter to the popcorn, how many calories would that be in total?" (903 calories)
- Remind students that they should be mindful of the calories when adding butter to popcorn. It is possible to turn a healthy snack into an overly caloric "junk" food item.
- Explain to the students that popcorn is a whole grain, meaning it contains the entire whole grain kernel—the bran, germ, and endosperm. In contrast, a refined grain has been milled to remove the bran and germ which contain much of the dietary fiber, iron, and B vitamins. Popcorn can help you meet the recommendation to "make half of your grains whole."
- Share the following popcorn nutrition facts with the students:
 - Per cup, popcorn contains 31 calories when air-popped, 55 calories when oil-popped, and 89 calories when lightly buttered.
 - Popcorn is a whole grain. It provides energy-producing complex carbohydrates.
 - Popcorn contains fiber, providing roughage the body needs in the daily diet.
 - Popcorn has no artificial additives or preservatives and is sugar-free.
 - Popcorn is ideal for between-meal snacking since it satisfies, but doesn't spoil, the appetite.
 - Three cups of popcorn equals one serving from the grain group.

Popcorn	Buttered [†] 1 cup (16g)	Oil popped [†] 1 cup (11g)	Air popped [†] 1 cup (9g)			
Amount Per Serving						
Calories	89	55	31			
Calories from Fat	63	27	0			
	% Daily Value*	% Daily Value*	% Daily Value*			
Total Fat	7g	11%	3g	5%	0g	0%
Saturated Fat	3g	15%	1g	5%	0g	0%
Cholesterol	10mg	3%	0mg	0%	0mg	0%
Sodium	136mg	6%	97mg	4%	0mg	0%
Total Carbohydrate	6g	2%	6g	2%	5g	2%
Dietary Fiber	1g	4%	1g	4%	1g	4%
Protein	1g	2%	1g	2%	1g	2%
Vitamin A	3%		0%		0%	
Iron	2%		2%		1%	

†Oil popped or microwaved, salted
‡Without salt
*Percent Daily Values are based on a 2,000 calorie diet

Concept Elaboration and Evaluation

- Ask the students the following questions:
 - Does steam have energy? (yes)
 - What evidence do we have to indicate that steam has energy? (*Steam inflated and burst the balloon. Steam caused the popcorn kernel to pop.*)
- Ask the students to consider some ways that steam energy might be used. Use the information in the [Engineering Expert Witness Blog](#) to discover how steam energy is used in power plants.
- Review and summarize the following key concepts:
 - Popcorn is a grain composed of three parts—the pericarp, germ, and endosperm. The endosperm contains water and starch.
 - When water is heated, the water turns from a liquid to a gas—steam. Gas molecules move around and take up any available space.
 - When a popcorn kernel heats up, the water in the endosperm boils and turns into steam. Pressure from the steam builds up inside the kernel, eventually becoming so great that the kernel bursts open.
 - Popcorn is a healthy and nutritious whole grain snack option.



We welcome your [feedback](#)! Please take a minute to tell us how to make this lesson better or to give us a few gold stars!

Enriching Activities

- Meet a popcorn farmer who lives on Popcorn Road by Popcorn Creek in Popcorn, Indiana in this [video field trip](#) of a real popcorn farm.

- Popcorn seeds can be used as food for people, but they can also be sprouted and grown into new plants if given the chance. Explore germination by sprouting corn seeds using the [Living Corn Necklace Kit](#) or the [Farming in a Glove \(corn seeds\) Kit](#).
- Pop popcorn in an air popper. Beforehand, ask students to predict whether the popped popcorn will weigh more or less than the popcorn kernels. Weigh the kernels in a bowl before popping and the popcorn in the same bowl after popping. The popped popcorn will weigh slightly less than the kernels. Explain that this is because the moisture inside the kernel escapes as steam when the popcorn pops. Add a little butter and salt to the popcorn and enjoy as a class snack.
- Learn about a small family farm that is growing popcorn and selling the cobs at farmers' markets in this [video](#).

Suggested Companion Resources

- Popcorn! (Book)
[\[https://www.agclassroom.org/teacher/matrix/resources.cfm?rid=871\]](https://www.agclassroom.org/teacher/matrix/resources.cfm?rid=871)
- The Popcorn Book (Book)
[\[https://www.agclassroom.org/teacher/matrix/resources.cfm?rid=870\]](https://www.agclassroom.org/teacher/matrix/resources.cfm?rid=870)
- Corn (Book)
[\[https://www.agclassroom.org/teacher/matrix/resources.cfm?rid=446\]](https://www.agclassroom.org/teacher/matrix/resources.cfm?rid=446)
- Corn is Maize: The Gift of the Indians (Book)
[\[https://www.agclassroom.org/teacher/matrix/resources.cfm?rid=189\]](https://www.agclassroom.org/teacher/matrix/resources.cfm?rid=189)
- Popcorn on the Cob (Kit)
[\[https://www.agclassroom.org/teacher/matrix/resources.cfm?rid=882\]](https://www.agclassroom.org/teacher/matrix/resources.cfm?rid=882)
- Living Necklace Kits (Kit)
[\[https://www.agclassroom.org/teacher/matrix/resources.cfm?rid=83\]](https://www.agclassroom.org/teacher/matrix/resources.cfm?rid=83)
- Get Popping! (Kit)
[\[https://www.agclassroom.org/teacher/matrix/resources.cfm?rid=878\]](https://www.agclassroom.org/teacher/matrix/resources.cfm?rid=878)
- Farming in a Glove (Corn Seeds) (Kit)
[\[https://www.agclassroom.org/teacher/matrix/resources.cfm?rid=793\]](https://www.agclassroom.org/teacher/matrix/resources.cfm?rid=793)

- How Stuff Works: Popcorn (Multimedia)
[<https://www.agclassroom.org/teacher/matrix/resources.cfm?rid=485>]
- Popped Secret: The Mysterious Origin of Corn (Multimedia)
[<https://www.agclassroom.org/teacher/matrix/resources.cfm?rid=568>]

Sources/Credits

1. <http://www.popcorn.org/Facts-Fun/Corny-Facts>
2. <https://specialcollections.nal.usda.gov/popcorn-exhibit#pop>
3. <http://www.popcorn.org/Facts-Fun/History-of-Popcorn/Recent-Popcorn-History>

Activity 3 was created for Utah Agriculture in the Classroom by Lyndi Perry.

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Organization Affiliation

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Curriculum Matrix: [agclassroom.org/teacher/matrix](https://www.agclassroom.org/teacher/matrix)