



POPCORN SCIENCE

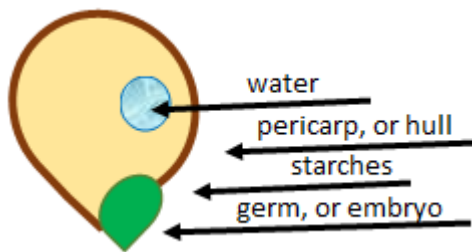


Popcorn is a very popular snack. You have probably enjoyed it in a movie theater, at a baseball game, and in your own home with family and friends. In fact, it is estimated that Americans eat more than 15 billion quarts of popped popcorn every year!

Popcorn originated in the Americas, and remnants of popcorn have been found at archeological sites in Mexico dating back to 3600 BC. When the first Europeans arrived in North America, they recorded seeing the Aztecs using popcorn to make headdresses and eating it at festivals.

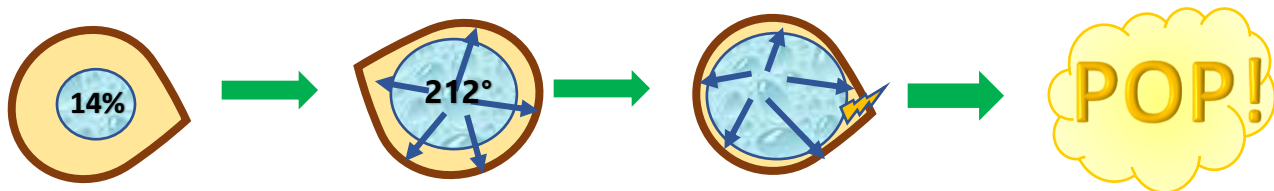
The scientific name for popcorn is *Zea mays everta*. Although popcorn looks like other types of corn while growing, only this special type of corn can pop. Farms in the "Corn Belt" of the United States produce most of the popcorn in the world. The "Corn Belt" includes the states of Illinois, Indiana, Iowa, Kentucky, Michigan, Missouri, Nebraska, and Ohio.

A popcorn kernel is a seed. Like all other seeds, it contains everything needed to create a new baby plant. It has a hard outer shell called the **pericarp**, or **hull**. Within that shell is the **germ** (embryo or baby) for a new plant, water, and starches, or **endosperm** that will serve as food for the seedling while it is sprouting.



Popcorn pops because of water that is trapped within the kernel. When water is heated, the water molecules move very fast, turn into steam, and expand. In chemistry, this is known as a **physical change**, a change in which the appearance or form of a substance may change but the substance remains the same.

As popcorn is heated, the pressure of the steam builds up in the kernel until it cracks the hull and bursts. The heating of the starch within the kernel cooks it and causes it to swell. When the kernel bursts, out it pops! Once the starch cools, it looks like the fluffy, yummy popcorn that we love to eat.



- After harvest, each kernel is dried until it contains the perfect amount of **moisture** (water), about 14%. An un-popped kernel is mostly water and starch.
- As the temperature increases to 212° F, the moisture in the corn begins to boil and turns into steam. The expanding water vapor puts pressure on the outer hull.
- The shell begins to crack, and the pressure continues to build up.
- The starches cook and swell, the shell **ruptures** (breaks open), the kernel turns inside out and pops into the air!
- The escaping steam makes a popping sound.

ACTIVITY: See how small changes affect the way a popcorn kernel pops

Parental supervision and assistance will be required for this activity because it requires the use of a sharp knife and hot stove!

Materials:

- Un-popped popcorn kernels, at least 70
- Stove
- Pot with lid
- Vegetable oil
- Oven
- Oven-proof bowl
- Potholders
- Sharp knife
- Three clear glasses
- 1 tsp. measuring spoon
- Spoon

1. Separate the popcorn into three piles with 20 kernels in each pile.
2. **Ask an adult** to cut a slit in 20 of the kernels in the soft white part of the shell. Keep the shell whole (not broken into pieces). Keep these kernels separate from the others.
3. Heat your oven to 350°. Place 20 uncracked kernels in the oven-proof bowl and bake them for 30 minutes. Use potholders to remove the bowl and let the kernels cool. Has the appearance of these kernels changed?
4. **With the help of an adult:** Place 2 teaspoons of cooking oil in the pot and heat the oil on medium high heat. Place 3 of your extra kernels in the pot. Place the lid on the pot and shake the pot a little until these kernels pop. Once they pop, remove them from the pot with a spoon.
5. Turn the heat down to medium and add 20 of the regular kernels. Shake the pot to cover the kernels with oil. Tilt the lid of the pot so the steam can escape. Wait about 2 minutes until the kernels have stopped popping. Remove the pot from the stove and remove the popcorn. After it cools, count the popcorn. How many kernels popped? What size are they? What color are they? Did they make a loud popping sound?
6. Add more oil and test 3 more of your extra kernels. Once they pop, remove them and set them aside. Add the 20 kernels with broken shells (the ones that were cut), to the pot, just as you did above. When they have stopped popping, remove them from the pot. Count the kernels to see how many have popped. Note the size and color of the popcorn. How do they compare with the first 20 unbroken kernels?
7. Repeat the same steps with the kernels that you pre-heated in the oven. Once again, remove them, count the popped and un-popped kernels, and note the size and color of the popcorn.
8. Place each set of 20 popped kernels in the clear glasses. Is the volume the same? (Are the glasses filled up to the same level?) How do they differ in color, size, and taste?

DISCUSSION:

- If you heated a good quality popcorn, most of the first batch of kernels popped and produced nice fluffy, tasty popcorn.

- The 20 kernels that were split probably didn't pop as well. If they did pop, the popcorn may have been smaller than the first batch. This is because the slit in the shell allowed the steam to escape. The steam is needed to mix with the starch and help cook the corn. With less water, the popped corn will be smaller. With less steam pressure to split the shell, these kernels were less likely to pop.
- The color of the 20 preheated kernels was probably darker. If it popped, the popcorn was smaller. Baking the kernels caused some of the water to evaporate through little holes in the shell. Not as much water pressure could build up to break the shell.
- If you filled the three glasses with the cooked popcorn, the popcorn that was not baked or cut had a greater volume (filled the glasses much higher) than the other two samples.



Facts about popcorn:

- ❖ Popcorn is planted in the spring. Farmers plant about 28,000 seeds per acre.
- ❖ The seedlings emerge from the soil in 10 days, and it takes 3 – 4 months for popcorn to mature.
- ❖ When popcorn is harvested, it contains between 16-20% water. It is carefully dried until the moisture content is just right.
- ❖ Most popcorn will pop when the temperature inside reaches 400 - 460°
- ❖ Other grains that pop and puff include sorghum, quinoa, millet, and amaranth.
- ❖ It is a good idea to store your popcorn in an airtight container. If the kernel dries out, the water concentration will be too low, and there won't be enough pressure in the shell to break it open.
- ❖ When making popcorn, it is important to apply the heat rapidly, rather than heat it slowly. The fast buildup of heat causes the pressure to build quickly to split the shell. Heating slowly softens the shell so that it will open at a lower temperature. The popcorn will not be as fluffy.
- ❖ Popcorn kernels that contain too much water will make popcorn flakes that are very chewy and dense.

ADDITIONAL RESOURCES

Books available from the Washoe County Library System:

[*Corn*](#) by Gail Gibbons

[*Eat Your Science Homework: Recipes for Inquiring Minds*](#) by Ann McCallum

[*Forces: Physical Science for Kids*](#) by Andi Diehn

[*Gourmet Popcorn: 100 Recipes for any Occasion*](#) by Georganne Bell

[*How to be Good at Science, Technology & Engineering*](#) by Robert Dinwiddie

[*Matter: Physical Science for Kids*](#) by Andi Diehn

[*Popcorn!*](#) by Elaine Landau

[*Popcorn*](#) by Alex Moran

[The Popcorn Book](#) by Tomie de Paola

[Popcorn: Poems](#) by James Stevenson

[Prize-winning Science Fair Projects for Curious Kids](#) by Joe Rhatigan

[Transferring Energy](#) by Torrey Maloof

Videos:

Discovery UK, "Popcorn – How it's made", <https://youtu.be/iM-CptBrSXM>

National Geographic Kids, "How Popcorn Works | How Things Work with Kamri Noel",
<https://youtu.be/RDRU064CZNU>

Tech Insider. "Why Some of the Kernels in Your Popcorn Don't Pop" <https://youtu.be/xw87efvHxQA>

Websites:

American Chemical Society, The Secret Science of Popcorn

<https://www.acs.org/content/acs/en/education/whatischemistry/adventures-in-chemistry/secret-science-stuff/popcorn.html>

Exploratorium, Popping Popcorn <https://www.exploratorium.edu/food/popping-popcorn>