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Ag in the Classroom
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SC Ag in the Classroom
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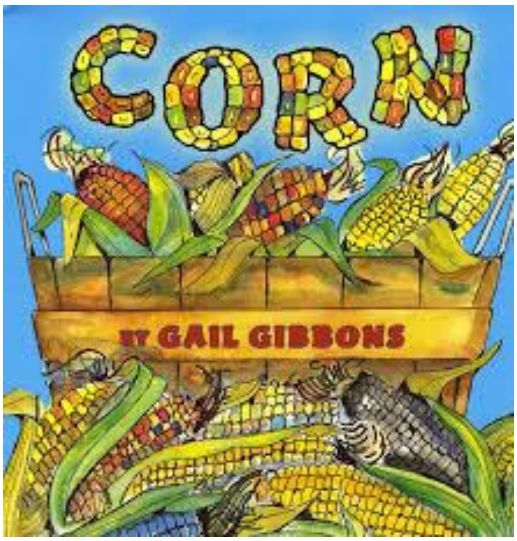
Corn

By: Gail Gibbons

Find out everything about this versatile and important grain–its history as a crop, the four main types, and how we grow and use it to make everything from food to paper to medicine! [1]



Did You Know? (Ag Facts) [2]

- There is one silk for every kernel in an ear of corn.
- An average ear of corn has 800 kernels, and there are approximately 72,000 kernels in one bushel of corn.
- Only one percent of corn planted in the United States is sweet corn.
- A single bushel of corn can sweeten about 400 cans of soda.
- Corn is grown on every continent except Antarctica.

Discussion Questions

- Why is corn such an important food source?
- What are the different types of corn?
- What are some products or by-products of corn?

Grade Level(s): 3-6

Purpose: Students will examine the growth, composition, history, and uses of corn as well as observe the growth of Indian corn and popcorn seeds, observe similarities and differences between the two varieties, and discuss heredity.

Vocabulary:

- **Corn Belt:** the area of the United States where corn is the predominant crop grown
- **biodegradable:** capable of being broken down through the actions of living organisms and natural processes over time
- **bioplastics:** a group of plastics made from biological materials like plant starches, cellulose, oils, or protein
- **bushel:** for corn, a unit of weight equal to 56 pounds
- **by-products:** in agriculture, secondary products produced from the main product of a crop or animal; for example, cornstarch is a by-product of corn
- **compostable:** capable of breaking down through the actions of living organisms in specific conditions to a defined outcome; generally, the conditions are moist, warm, and aerobic, and the end product is non-toxic compost that can enhance soil and support plant growth
- **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
- **pericarp:** the outer, protective covering of the corn kernel
- **cross-pollination:** transfer of pollen from one plant to another
- **ear:** female part of a corn plant that contains the cob, the silks, and the eggs that will become kernels
- **hybrid:** produced by cross-pollinating two different inbred parent plants; plants are high-yielding and vigorous but results of saving seed are unreliable
- **kernel:** the seed of a corn plant and the part that we eat
- **open-pollination:** pollination that occurs naturally without human interference; open-pollinated varieties are developed simply by saving seed from the most desirable plants, resulting in high genetic diversity among offspring
- **self-pollination:** transfer of pollen from the male part of a flower to the female part of that same flower or another flower on the same plant; in corn this rarely happens in the field, but it may be done by plant breeders to develop desired traits
- **tassel:** the male part of a corn plant that emerges from the top of the plant and bears many small flowers that release pollen grains

Background Agricultural Connections: [3]

The **Corn Belt** is a region of the United States where corn is the predominant crop grown. Iowa and Illinois are the top corn-producing states, and they typically grow just over one-third of the US crop. Other major states for corn production include Nebraska, Minnesota, Indiana, Wisconsin, Michigan, South Dakota, Kansas, Missouri, Kentucky, and Ohio. These twelve states can be considered part of the Corn Belt. Warm, rainy summers and deep, fertile soils make this region particularly well suited for growing corn.

An ear of corn has an average of sixteen rows with 800 kernels. There are approximately 1300 kernels in one pound of corn. An acre (about the size of a football field) of corn can yield more than 13 million kernels. In the United States, corn production is commonly measured in **bushels**. This measurement originated as a unit of volume but has been standardized to units of weight for different commodities. One bushel of shelled corn is equivalent to 56 pounds (25 kg).

First domesticated in Mexico, corn is now grown on every continent of the world except Antarctica. The United States produces more corn than any other country. The scientific name for corn is *Zea mays*. All types of corn belong to this species, including sweet corn, popcorn, dent (field) corn, flour corn, and flint corn. Dent corn is the type most widely grown and processed in the United States. Hybrids of corn, produced by crossbreeding different varieties, have been developed to grow well in varying conditions and locations worldwide. The development of hybrid varieties, along with synthetic fertilizers and new farm machinery, has facilitated huge increases in corn productivity. Today, more corn can be grown on less land than ever before.

Similarly, advances in technology allow us to use more components of the processed corn kernel than ever before. One hundred years ago, starch was the main product used from refined corn, while the rest of the kernel was thrown away. Today, there are uses for every part of the kernel—even the water in which it is processed. The corn seed (kernel) is composed of four main parts: the **endosperm**, the **pericarp**, the **germ**, and the **tip cap**. The endosperm makes up most of the dry weight of the kernel and provides the source of energy for the seed. The pericarp is the hard, outer coat that protects the kernel both before and after planting. The germ is the living embryo of the corn kernel. It contains genetic information, vitamins, and minerals that the kernel needs to grow. The tip cap is where the kernel is attached to the cob and is the major entry path into the kernel for water and nutrients.

Corn is a versatile crop. It is the major grain grown for livestock feed by farmers in the United States, leading all other feed crops in value and volume of production. Corn is a major component in foods like cereals, peanut butter, and snack foods, and it is also processed into a wide range of industrial products, including ethanol. The kernel is used as oil, bran, starch, glutamates, animal feed, and solvents. The silk is combined with other parts of the corn plant to be used as part of animal feed, silage, and fuels. Husks are made into dolls and used as filling materials. The stalk is used to make paper, wallboard, silage, syrup, and rayon (artificial silk).

Corn can also be used to make a type of plastic known as **bioplastic**. Commonly, plastic is made from petroleum, a fossil fuel that is a nonrenewable resource. In contrast, bioplastic is made from biological materials—plant starches, cellulose, oils, or proteins. Unlike petroleum-based plastics, bioplastics are made from renewable resources such as corn, potatoes, tapioca, and casein (milk protein). One example of a bioplastic application is packing peanuts—the loose fill that goes all over when you open a package. Some packing peanuts are made of polystyrene (Styrofoam), which is a petroleum-based plastic. Corn-based packing peanuts are made of over 99% cornstarch and a very small percentage of food-grade oil. These packing peanuts are non-toxic, biodegradable, and **compostable**.

A Brief History of Corn [3]

Materials:

- *United States Map*
- *A Brief History of Corn* handout
- *A Golden Nugget* PowerPoint (LINK HERE)

Procedures:

1. Provide each student with a copy of the *A Brief History of Corn* handout. Have students do a close reading of the text.
2. Have students watch the following video on corn: https://intotheoutdoors.org/topics/a-maize-ing-corn/#available-lessons
3. Using the map of the United States, have students identify and highlight the states that are part of the Corn Belt—Iowa, Illinois, Nebraska, Minnesota, Indiana, Wisconsin, Michigan, South Dakota, Kansas, Missouri, Kentucky, and Ohio. Explain to the students that the warm, rainy summers and deep, fertile soils in this region of the United States are particularly well suited for growing corn.
4. Use the *A Golden Nugget* PowerPoint to discuss the different types of corn plants and their uses, the structure of a corn kernel, and the functions of each part of the kernel.
5. Using the information from the *Background Agricultural Connections*, discuss the uses of corn. Use the following questions to guide the discussion:
    a. Who used corn in ancient times?
    b. What are some of the ways corn is used today?
    c. Where is most of the corn grown in the United States?
    d. How have the uses of corn changed over time?
    e. What are the parts of the corn kernel called, and how are these parts useful?

Inherited Traits in the Living Corn Necklace [4]

Materials:

{Day One}

- Pictures of crop plants
- Pictures or ears of dried popcorn and Indian corn

{Day Two}

- Cotton balls, 1 per student*
- Small plastic jewelry bags, 1 per student*
- Popcorn seeds, 1 per student*
- Indian corn seeds, 1 per student*
- Necklace-length piece of yarn, 1 per student*
- Water, 1 cup per group

- Permanent markers, 1 per group
- Hand lenses, 1 per student or pair
- Metric rulers, 1 per student or pair
- Pictures of mature popcorn and Indian corn plants
- *We're Expecting...* activity sheet, 1 per student

*These items are included in the Living Necklace Kit, which is available for purchase from agclassroomstore.com.

Procedures:

{Day One}

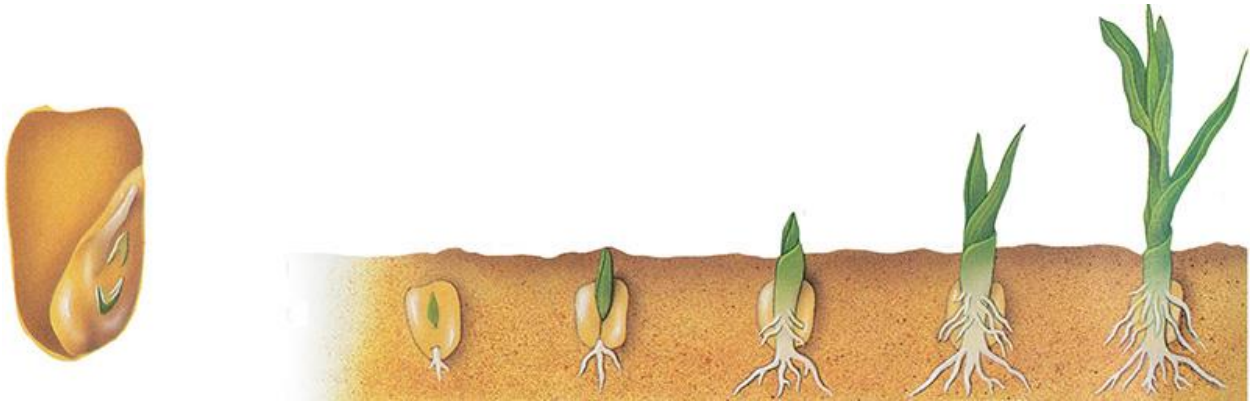
1. Remind students about the similarities and differences among humans that come from inherited traits. Tell them that the class is now going to investigate the amount of variation present in crop plants.
2. Divide students into groups and provide each group with a picture of a field of crop plants, such as corn, beans, etc. Ask each group to make a chart of the similarities and differences they can see between plants in the pictures. Discuss how the amount of variation they observe compares to the amount of variation that can be observed in humans. As a class, brainstorm reasons why farmers might not want variation among plants they grow to produce crops.
3. Show each group of students an ear of dried popcorn and an ear of Indian corn. If you do not have ears of corn available, you can use pictures or have students compare all of the popcorn seeds and all of the Indian corn seeds that will be used in Day Two.
4. Ask each group to make a chart of similarities and differences between the kernels on an ear (each kernel is an individual offspring of the plant that produced the ear). As a class, discuss their observations. Discuss the possible sources of variation (sexual reproduction, open pollination). Also compare the traits of the two corn varieties.
5. Explain to the students that in general, it is easier for farmers to manage uniform crops. For example, most corn is harvested using a machine called a combine. All of the corn is harvested at the same time, so it is best if it all matures at the same time. However, sometimes variation is desirable. Indian corn is used mostly for ornamental purposes, so variation in the color of the kernels is desirable.

{Day Two}

1. Tell the students that they will continue their investigation of corn by observing how corn seeds germinate and begin to grow. They will observe two varieties, Indian corn and popcorn, that have been selected over time for different traits.
2. Provide each student with one popcorn seed and one Indian corn seed. Ask each student to begin his or her corn journal by drawing a picture of each seed and writing several sentences to describe it.
3. Provide groups with the materials needed for each student to make a "Living Necklace" (plastic jewelry bag, cotton balls, and yarn), permanent marker(s) and a cup of water. Direct students to make their necklaces as follows:
    a. Use the permanent marker to label one side of the bag *P* and the other side *I*.
    b. Dip a cotton ball in water so that it is thoroughly wet but not dripping. Excess water will cause the seeds not to sprout.

c. Place the cotton ball in the small plastic bag.
d. Put one popcorn seed on the side of the cotton ball facing the label *P*.
e. Put one Indian corn seed on the other side of the cotton ball, facing the label *I*. The labels will help students remember which seed is which.
f. Seal the bag. String the yarn through the hole in the jewelry bag. Tie a knot in the end of the string to form a necklace.
g. Bags can be hung from tacks on a bulletin board and taken down for student observations.
h. *Teaching Tip: The corn seeds will sprout in three to six days. Starting on a Friday and making the first observations on Monday will speed up this activity.*

4. For one week have students record in their journals the changes they observe in their seeds, including information about observable traits such as: number of days from "planting" until the root and the shoot can be seen; root and shoot lengths and color; and number of leaves and roots.
    a. Use hand lenses to observe the roots and shoots as they emerge and grow.
    b. Use rulers to measure the length of roots and leaves as they grow.
    c. *Teaching Tip: It is difficult to take the seedlings out of the bags and get them back in without breaking the roots. Ask students to measure through the bag instead. The roots will curl, so you may want to suggest measuring them in sections and estimating as necessary.*
5. In small groups, have students make charts or graphs of the data they collected for measurable traits (leaf and root length). Ask them to look for differences between the popcorn and Indian corn.
6. As a class, discuss how each group compared their data for popcorn and Indian corn. Which kinds of charts or graphs worked the best? Were there noticeable differences between the popcorn and Indian corn seedlings?
7. Discuss how plant breeders control inheritance and work to develop seeds that will reliably express desired traits. Popcorn has been selected for different traits than Indian corn.
8. Compare the traits of the corn seedlings to those of mature corn plants (using photographs).
9. Use the *We're Expecting...* activity sheet to review the difference between cross-pollination and self-pollination and to introduce the concept of dominant and recessive traits.



Extension Activities:

- Watch the 3-minute "How Stuff Works" video clip about Corn Plastic.
- Learn more about how petroleum-based plastic is made and recycled by watching the video From Oil to Plastic.
- Make corn Johnnycakes in your classroom. The batter is simple to prepare and cooks quickly on an electric griddle.
- Read Issue 5 of Ag Today titled *Agriculture in Society.* This reader can be printed or accessed digitally. Students will learn the term sustainability and what that means to farmers who need to produce 60% more food with the same amount of land in order to feed a growing world population. Learn what byproducts are and how they are used, how food packaging has decreased waste, and how farmers use technology such as various tools, robots, and hand-held devices to improve their efficiency.
- Play the My American Farm interactive game Amazing Grains.
- View the video Farm to Car to explore how plant-based plastics are being used in the automotive industry.

Suggested Companion Resources:

- A True Book: Corn
- Carlos and the Cornfield
- Corn in the Story of Agriculture
- Corn is Maize: The Gift of the Indians
- Eating the Plates
- Energy Island
- Four Seasons of Corn: A Winnebago Tradition
- If You Lived In Colonial Times
- My Family's Farm Book Series
- Popcorn Country: The Story of America's Favorite Snack
- Popcorn!
- Step into the Inca World
- The Popcorn Book
- Tomatoes, Potatoes, Corn & Beans
- Crazy About Corn
- Farming in a Glove (Corn Seeds)
- Get Popping!
- Grains and Legumes of the World
- Living Necklace Kits
- Packing Peanuts
- Popcorn on the Cob
- Three Sisters Seed Packet

- Corn and Soybean Processing and Utilization Poster
- America's Heartland: Nebraska Corn Farm
- Better Paper, Plastics with Starch
- How It's Made: Corn Tortillas
- How Stuff Works: Corn Plastic
- How Stuff Works: Popcorn
- NASA Shows U.S. Corn Belt Literally Glowing with Productivity
- Popped Secret: The Mysterious Origin of Corn
- Those Amazing Kernels of Corn!
- Ag Today
- Renewable vs Nonrenewable vs Inexhaustible Resources e-magazine
- In The Three Sisters Garden
- Evolution of Corn
- My American Farm

Sources/Credits:

1. Gibbons, Gail. *Corn*, Holiday House, 2008.
2. Iowa Corn Growers Association
3. Oregon, Utah, and Illinois Ag in the Classroom
4. Utah Ag in the Classroom

Suggested SC Standards Met:

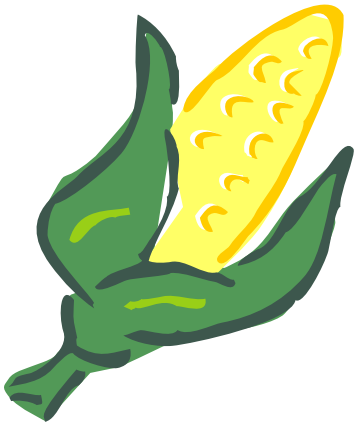
English/Language Arts:

- 3.RI.5.1 Ask and answer literal and inferential questions to determine meaning; refer explicitly to the text to support inferences and conclusions.
- 3.RI.8.2 Use knowledge of appendices, timelines, maps, and charts to locate information and gain meaning; explain how these features contribute to a text.
- 4.RI.5.1 Ask and answer inferential questions to analyze meaning beyond the text; refer to details and examples within a text to support inferences and conclusions.
- 4.RI.8.2 Apply knowledge of text features to gain meaning; describe the relationship between these features and the text.
- 5.RI.6.1 Summarize a text with two or more central ideas; cite key supporting details.
- 6.RI.6.1 Provide an objective summary of a text with two or more central ideas; cite key supporting details

Science:

- 3.L.5B.1 Obtain and communicate information to explain how changes in habitats (such as those that occur naturally or those caused by organisms) can be beneficial or harmful to the organisms that live there.
- 4.L.5A.1 Obtain and communicate information about the characteristics of plants and animals to develop models which classify plants as flowering or nonflowering and animals as vertebrate or invertebrate.
- 4.L.5A.2 Analyze and interpret data from observations and measurements to compare the stages of development of different seed plants
- 4.L.5A.4 Construct scientific arguments to support claims that some characteristics of organisms are inherited from parents and some are influenced by the environment.
- 5.L.4B.1 Analyze and interpret data to explain how organisms obtain their energy and classify an organisms as producers, consumers (including herbivore, carnivore, and omnivore), or decomposers (such as fungi and bacteria).
- 6.L.4A.1 Obtain and communicate information to support claims that living organisms (1) obtain and use resources for energy, (2) respond to stimuli, (3) reproduce, and (4) grow and develop.
- 6.L.5B.1 Construct explanations of how the internal structures of vascular and nonvascular plants transport food and water. 6.L.5B.2 Analyze and interpret data to explain how the processes of photosynthesis, respiration, and transpiration work together to meet the needs of plants.

Name _____



A Brief History of Corn

Since ancient times, corn has played an integral role in human history. Corn is in the grass family, and it is native to the Americas. The exact origin of the grain remains unknown, but tiny ears of corn have been discovered at ancient village sites and in tombs of early Native Americans. Evidence of corn in central Mexico, where it was domesticated from a wild grass, suggests it was used there as long as 7,000 years ago. Cultivated corn is known to have existed in the southwestern United States for at least 3,000 years.

To the Aztecs in Mexico, corn was a staple of their diet that provided flour and vegetable dishes. Here in the United States, many different Native American tribes have traditionally grown corn—also known as maize—and used it for both food and utilitarian purposes. Corn was so important to some Pueblo tribes of the Southwest that it was considered one of the three sacred foods (along with beans and squash), so sacred that some groups even worshipped it. Indeed, Native American mythology is rich with stories involving corn and important religious events. Eastern tribes shared their knowledge of corn production with the early European settlers, saving many colonists from starvation.

Use of Corn

Along with wheat and rice, corn is one of the world's major grain crops. It is the largest grain crop grown in the United States today, and the United States is the largest producer of corn in the world. Corn is used as food for humans and as feed for livestock. Many American foods come from corn. We eat the kernels of sweet corn right off the cob and heat popcorn kernels for a tasty snack. Dent corn (also called field corn) can be processed and separated into its different components to make corn-based sweetener, starch, meal, and oil, which are used in a wide variety of foods.

Corn cobs have been used as a soft-grit abrasive and to provide furfural, a liquid required in the manufacturing of nylon fibers. Corn has been used as a source for producing biodegradable plastics. Additionally, ethanol (a type of renewable fuel made from corn) has shown the possibility of becoming a major new fuel for the world's automotive industry. From foods of the past to fuels of the future, this highly diverse crop has played a major role in human civilization.

Corn Production

As miraculous as the many uses for corn may be, the way corn develops and grows into a productive plant is equally fascinating. To understand the vast amount of seed produced by corn plants, consider the following example: A single seed (kernel) can produce a plant that will contain at least 600 kernels per ear. On one acre of land, anywhere from 22,000 to 35,000 individual plants may be grown. In general, hybrid corn varieties produce one to two ears per plant. If each plant produces at least one ear of corn, the yield will be 13,000,000 (thirteen million) kernels of corn from that single acre. A 400-acre farm would then yield over five billion kernels. In addition, consider that US corn yields have increased more than 500% since the early 1900s. With the development of technologies like hybrid corn varieties, synthetic fertilizers, and new farm machinery, more corn can be produced on less land than ever before.

Adapted from The Nature of Corn, a publication on Environmental Impacts of Corn and Corn Products, by the Illinois Corn Marketing Board. Visit their web site at www.ilcorn.org.

United States Map

Locate and color the Corn Belt states. Corn is the predominant crop grown in these states, which have deep soils and warm, rainy summers. Different regions of the country specialize in producing different agricultural products based on what crops are most suited to their climate and soil and what products the market demands.

We're Expecting...

Make a prediction based on the information given below, and justify your answer; you may draw a picture to help explain:

1. What would happen if your popcorn plant grew to maturity, flowered, self-pollinated, went to seed, and you took the seeds and planted them?
   Would that seedling be likely to look like the seedling you have observed, or would it be likely to look different?

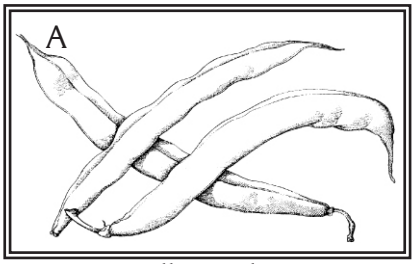
2. What would happen if your popcorn plant grew to maturity, flowered, was cross-pollinated by a popcorn plant from the person sitting next to you, and you took those seeds and planted them?
   Would that seedling look more like the seedling you have observed, or less like the seedling you have observed?

3. What would happen if your Indian corn and popcorn plants grew to maturity, flowered, cross-pollinated, and you took the seeds and planted them?
   Would that seedling look more or less like the seedlings you have observed?

The longer shelled beans from picture *A* are a dominant trait, but the yellow color is recessive. The green color of the beans from picture *B* are a dominant trait, but the short shells are recessive. Use this information to help you predict what the offspring will look like if the following scenario occurs.

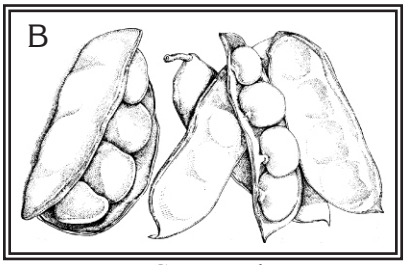
4. If *A* and *B* cross-pollinate each other, predict what the offspring may look like by drawing a picture of it in *X*.

5. If *A* self-pollinates, predict what the offspring may look like by drawing a picture of it in *Y*.



Yellow Pods

X	Y



Green Pods