Corn Field Math and Science

Grades 6-8

Math, Science, Social Studies, ELA, Plant Science, Food Science and Technology

Objectives

Students will learn about corn's place in the history of the Americas. Students will solve real life math problems using corn production. Students will classify Newtonian and Non-Newtonian substances and create polymers using cornstarch and corn syrup.

Vocabulary

bushel: A unit of measurement usually equal to 35 liters or 9.5 gallons
corn: A plant that produces large grains, or kernels, set in rows on a cob. Its many varieties produce numerous products, highly valued for both human and livestock consumption.
dent corn: This type of corn is used for animal feed, for making corn syrup, and for everything from fuel to biodegradable plastics.
domestication: adapted from a wild state to living with human beings and serving their purpose.
ethanol: a colorless, volatile, pungent liquid made from corn which can be burned as a fuel.
F1 hybrid: first generation seed produced by cross pollinating two different parent plants
flint corn: It is distinguished by a hard outer shell and kernels with a range of colors
heirloom: open pollinated plant varieties that often have historical significance
hybrid: The offspring of two animals or plants of different breeds varieties, species, or groups, especially as produced through human manipulation for specific genetic characteristics
maize: Native American name for corn. Also called Indian corn.
molecule: the smallest physical unit of an element or compound, consisting of one or more like atoms in an element and two or more different atoms in a compound.
monomer: a molecule that can be bonded to other identical molecules to form a polymer
Newtonian fluid: a fluid in which the viscosity is constant, regardless of pressure or temperature
non-Newtonian fluid: viscosity of this substance changes changes under pressure
open pollinated: a horticultural term meaning that the plant will produce seeds naturally. When these seeds are planted they will reliably reproduce the same plant as the parent.
pollinate: pollen placed on the stigma of a plant for the purpose of creating seeds, flowers, fruit.
polymer: a substance that has a molecular structure consisting chiefly or entirely of a large number of similar units bonded together, e.g., many synthetic organic materials used as plastics and resins.
porridge: a soft cereal or meal boiled in water or milk until thick.
popcorn: Grains with a hard, moisture resistant shells surrounding dense pocket of starch and will pop when heated
silage: the entire aboveground portion of the corn plant (including ear) that is harvested by cutting and chopping the plant before it reaches maturity. It is stored in silos or packed into above-ground pits and used for feed**.**
sweet corn: It is picked when it is immature, and is enjoyed as a vegetable, rather than being left to dry and consumed as a grain.
teosinte: the wild grass plant that corn was derived from
yield: The amount of a certain crop that is produced on a farm.
viscosity: the flow resistance of simple fluids

Background

Corn was derived from a native grass, known as **teosinte.** While the exact origin is unknown, tiny ears of corn have been discovered at ancient village sites and in tombs of early Americans. Evidence of corn in central Mexico suggests it was grown there as long as 9000 years ago. Teosinte is still grown in Mexico and Central America today. For more information about the **domestication** of corn or maize, have students watch the 17 minute video: **Popped Secret** - *the Mysterious Origin of Corn*: https://www.biointeractive.org/classroom-resources/popped-secret-mysterious-origin-corn

Native Americans and early settlers in the United States have grown corn, also known as **maize**, in the southwestern US for at least 3000 years. Since that time is has been used it for both food and utilitarian purposes. Eastern tribes shared their knowledge of corn production with early European settlers, an act which saved many from starvation. Early American colonists dried corn and ground it as meal for flour. They used the ground corn in **porridge**, cakes and bread.

Along with wheat and rice, corn is one of the world's major grain crops. It is the largest grain crop grown in the US. About 9 percent of all the corn grown is used to produce food for humans. These foods include corn meal, cooking oils, margarine, and corn syrups and sweeteners (fructose). Sixty four (64) percent of all corn grown is used as feed for livestock.

In addition to the grain, corncobs are used in the manufacturing of nylon **polymers** and as a source for producing biodegradable plastics. **Ethanol**, a renewable fuel made from corn, is blended with much of the petroleum-based fuel sold today to extend the world's oil supply.

Corn can be grown in much of Oklahoma, but primary production is in the Panhandle area. In Oklahoma, corn is harvested for either grain or silage with most of the grain going to dairies, animal feeding operations and poultry operations. About 330,000 acres of corn are planted for grain each year, with an average **yield** of 137 **bushels** per acre for a total of 45.2 million bushels of grain. One bushel of corn is equal to 56 pounds. An additional 20,000 acres of corn produces 260,000 tons of **silage**.

Corn is **pollinated** by wind and is typically planted in 30-inch rows. A single seed (or kernel) of corn may produce a plant which yields more than 600 kernels of corn per ear. On one acre of land, anywhere from 22,000 to 35,000 individual plants may be grown. **Hybrid** corn is developed to produce from one to two ears per plant. Ears per plant are often determined by moisture availability and soil fertility. Through better soil conservation practices, fertilizer use, better seed quality, and water availability, corn yields have increased 125 percent since 1950.

There are six types of corn kernels: flint, dent, pop, sweet, flour and waxy. Flour corn is mostly grown in the Andean region of South America and is used to make corn flour. Waxy corn is grown in China and has a texture that is more like sticky rice. There are open pollinated "heirloom" varieties of each type.

Dent corn, which is also known as "field corn," is an easy type of corn to spot -- there's a dent in the crown of each individual kernel of corn. It has a high starch and low sugar content. Because it's not meant to be eaten fresh, dent corn is harvested in its mature stage when the kernels are dry and then processed. Most dent corn grown in the U.S. winds up as animal feed. However because of its soft starch, dent corn is used as a grain in products like chips and masa (a corn flour used to make corn tortillas).

Sweet corn is what you eat as a vegetable. It has a high sugar content, which is why it's desirable as a fresh corn. Sweet corn occurs as a spontaneous mutation in field corn. Early farmers saved seed from this mutation and it was grown by several Native American tribes. The Iroquois gave the first recorded sweet corn (called 'Papoon') to European settlers in 1779. Open pollinated cultivars of white sweet corn started to become widely available in the United States in the 19th century. The first hybrid sweet corn was produced in 1933. Unlike other corn varieties, sweet corn is picked while immature, before the sugar has a chance to turn into starch. You may also see hybrid super-sweet corn varieties with the sugar content enhanced for a sweeter flavor.

Flint corn is also known as Indian corn or calico corn, and it's even harder than dent corn. If you see decorative corn (those fall-colored ears with the husks still on them), it's almost certain to be flint corn. However, flint corn has a high nutrient value and once the grains are dried, they can be used for any number of foods, including corn meal, corn flour, hominy, polenta, and grits. With it's bright colors, when you see red or blue corn tortilla chips, you can be sure they came from flint corn.

Popcorn is a particular variety of flint corn. The kernels are dried to a moisture level of 13.5%. When the kernels are heated, the remaining moisture turns to steam and the kernels pop inside out. Most of the world's popcorn is grown in the US Corn Belt of Iowa, Illinois, Indiana, Kansas, Kentucky, Michigan, Missouri, Nebraska and Ohio.

Heirloom is a term for **open pollinated** plant varieties that have historic significance**.** Because most of the corn grown commercially or in home gardens is a hybrid (a combination of two or more varieties), there is a movement to preserve and grow heirloom varieties of corn to preserve genetic diversity. In the case of one variety, maintaining the variety came down to two ears of corn. Jimmy Red is a crimson red dent corn with a rich and oily germ that, back in the day, was known for making outstanding moonshine. When the last bootlegger on James Island, South Carolina died in the early 2000s, the family gave the last two ears to a well-known seed saver. The farmer carefully planted and saved seed from the resulting crop for five years before sharing with others who would in turn, plant and share seeds.

Additional Reading

Chen, Qiuyue; Samayoa, Luis F.; Yang,Chin J.; Bradbury,Peter J.; Olukolu,Bode A.; Neumeyer, Michael A.; Romay,Maria C. Sun, Qi; Lorant, Anne; Buckler, Edward S.; Ross-Ibarra, Jeffrey; Holland, James B.; Doebley, John F., *The genetic architecture of the maize progenitor, teosinte, and how it was altered during maize domestication*, Version 2, PLOS Genetics, May 14, 2020 https://doi.org/10.1371/journal.pgen.100879

Gibbons, Gail, *Corn*, Holiday House, 2009

Giesel, Theodor Seuss, Bartholomew and the Oobleck, Random House Children's Books, 1949

Rhoads, Dorothy, *The Corn Grows Ripe*, Puffin, 1993.

Websites

Thomas Jefferson National Accelerator Facility—Office of Science Education: http://education.jlab.org
https://www.smithsonianmag.com/smart-news/rethinking-corny-history-maize-180971038/
http://nativetech.org/cornhusk/cornhusk.html
https://www.biointeractive.org/classroom-resources/popped-secret-mysterious-origin-corn

Activity 1: Corn Field Math and Science, (Math) 1 50 minute class period

Students will use corn to calculate measures of central tendency and solve real world agricultural math problems

Oklahoma Academic Standards

Activity 1: Corn Field Math and Science (Math)

6.D.1 7.D.1 PA.D.1	Display and analyze data in a variety of ways.
6.D. 2 7.D.2 PA.D.2	Calculate probabilities and reason about probabilities using proportions to solve real-world and mathematical problems.

Materials:

- Dried corn on the cob (one per student or one per group)
- Activity 1, Worksheet 1 **"Central Tendency"**
- Activity 1 Worksheet 2 **"Cornfield Math"**
- Calculators
- Computers and/or resource materials
- Rulers

Procedures

1. Give each student or group of students one ear of dried corn on the cob.
   - —Students will estimate how many kernels are on the ear of corn.
   - —Students will count the kernels.
   - —According to the background, an ear of corn can have more than 600 kernels of corn per ear. Does your ear have more or less kernels than 600?
   - —Hand out Worksheet 1 **"Central Tendency"**
   - —Students will record the number of kernels from each ear and then find the mean, the median and the mode of the data
   - —Students will determine what percentage of the ears of corn had more kernels than 600 and what percentage had less.
2. Hand out Worksheet 2 **"Cornfield Math."**
   - —Students will work in pairs or groups to solve the math problems.
   - —Students will check answers after completing the first two before continuing.
   - —In a class discussion, students will agree or disagree with the reasoning of other classmates and explain their positions.

Corn Field and Math Science

Activity 1 Worksheet 1: Central Tendency

Name: _____ Date: _____

An ear of corn has an average of 600 kernels per ear. An average is a measure of central tendency called the mean. Other measures of central tendency are the median and the mode.

After counting the number of kernels on each ear of corn, record the number of kernels on each ear from smallest to largest in the space below:

Calculate the mean: _____

Did your corn sample have more or less kernels than the average?

Find the median: _____

Find the mode: _____

Which measure of central tendency best describes your data set?

How many ears had 600 kernels or more? _____

How many ears had less than 600? _____

Calculate the percentage of ears with 600 or more kernels _____

Calculate the percentage of ears with less than 600 kernels _____

If the kernels from your ear of corn were all planted and each kernel produced one ear of corn with the same number of kernels as the original ear of corn, how many kernels of corn will your ear of corn produce?

_____

Corn Field and Math Science

Activity 1 Worksheet 2: Cornfield Math

Name: _____ Date: _____

Use your calculator and other mathematical tools to solve the following problems. Compare your methods with a partner.

1. a) An acre of land is 43,560 sq. ft. How long is one side of a square acre?

   b) If the rows are 2.5 ft. apart, how many rows are there?

   c) How many corn plants will be in each row if there are 22,000 plants in a square acre?

2. Each corn plant produces one ear of corn. There are 600 kernels per ear. How many kernels are produced on 1 acre of land?

WAIT: CHECK YOUR ANSWERS TO THE FIRST TWO PROBLEMS BEFORE CONTINUING.

3. There are 135 bushels of corn produced per acre. How many kernels of corn are in a bushel?

4. A farmer has 640 acres planted in corn. How many bushels of corn will this yield if each plant produces two ears?

5. Corn is selling for $2.40 a bushel. Farmer A's plants produce two ears per plant, while Farmer B's plants produce one. Compare their earnings per acre.

6. The yield has increased by 125% or by a factor of 2.25 since 1950. It is 135 bushels today. What was it in 1950? Explain in writing how you completed your answer.

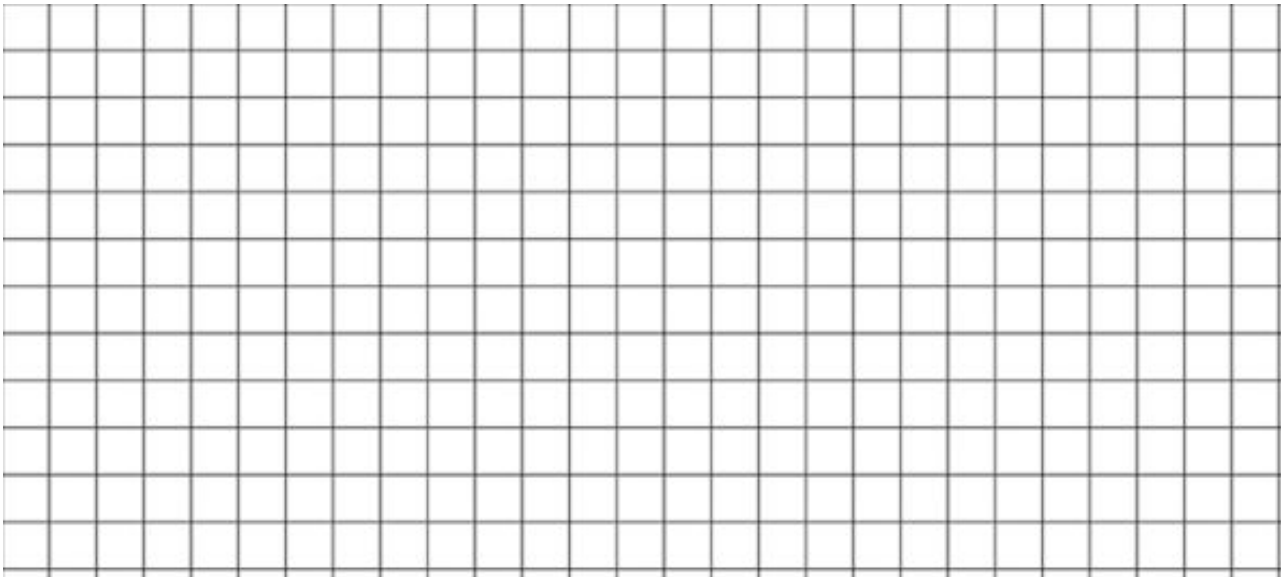
Corn Field and Math Science

Activity 1 Worksheet 2: Cornfield Math (continued)

Name: _____ Date: _____

Use your calculator and other mathematical tools to solve the following problems.

7. The farmer decided to plant 320 acres in three different varieties of corn. Use the graph below to construct a model of the farmer's land. Label each section, and complete the calculations. Show your work.



Discuss your work on this question with a partner or in a cooperative group.

a) Variety A produces one ear per plant. the farmer planted 1/3 of his 320 acres in Variety A. How many bushels of corn should Variety A produce?

b) Variety B produces two ears per plant. the farmer planted half of his 320 acres in Variety B. How many bushels of corn Variety B produce?

c) Variety C produces 1.5 ears per plant. The farmer planted the rest of his acreage in Variety C. How many bushels of corn should Variety C produce?

d) What is the total yield the farmer can expect for the entire 320 acres?

e) How much would the farmer receive from the sale of the corn at $2.40 a bushel?

f) The price of grain goes up and down on a regular basis. Use the internet to find the price of corn today $_____. At that price, how much would the farmer receive from the sale?

Corn Field and Math Science

Activity 1 Worksheet 2: Cornfield Math ANSWER KEY

Name: _____ Date: _____

Use your calculator and other mathematical tools to solve the following problems. Compare your methods with a partner.

1. a) An acre of land is 43,560 sq. ft. How long is one side of a square acre?

√43,560 = 208.71 ft. per side

b) If the rows are 2.5 ft. apart, how many rows are there?

208.71 ÷ 2.5 = 83.48 OR 83.48 + 1 = 84.48 (if you add a row on each side rather than start from the edge, so the side of the field counts as one row)

c) How many corn plants will be in each row if there are 22,000 plants in a square acre?

22,000 ÷ 83.48 = 263.54 or 22,000 ÷ 84.48 = 260.42

2. Each corn plant produces one ear of corn. There are 600 kernels per ear. How many kernels are produced on 1 acre of land?

22,000 x 600 = 13,200,000

WAIT: CHECK YOUR ANSWERS TO THE FIRST TWO PROBLEMS BEFORE CONTINUING.

3. There are 135 bushels of corn produced per acre. How many kernels of corn are in a bushel?

13,200,200 ÷ 135 = 97,777.78

4. A farmer has 640 acres planted in corn. How many bushels of corn will this yield if each plant produces two ears?

640 x 135 = 86,400 x 2 =172,800 (2 ears per plant)

5. Corn is selling for $2.40 a bushel. Farmer A's plants produce two ears per plant, while Farmer B's plants produce one. Compare their earnings per acre.

Farmer A: $2.40 x 270 = $648 per acre

Farmer B: $2.40 x 135 = $324 per acre

6. The yield has increased by 125% or by a factor of 2.25 since 1950. It is 135 bushels today. What was it in 1950? Explain in writing how you completed your answer.

x ÷ (125%)x = 135

2.25x = 135

135 ÷ 2.25 = 60

X = 60 bushels of corn

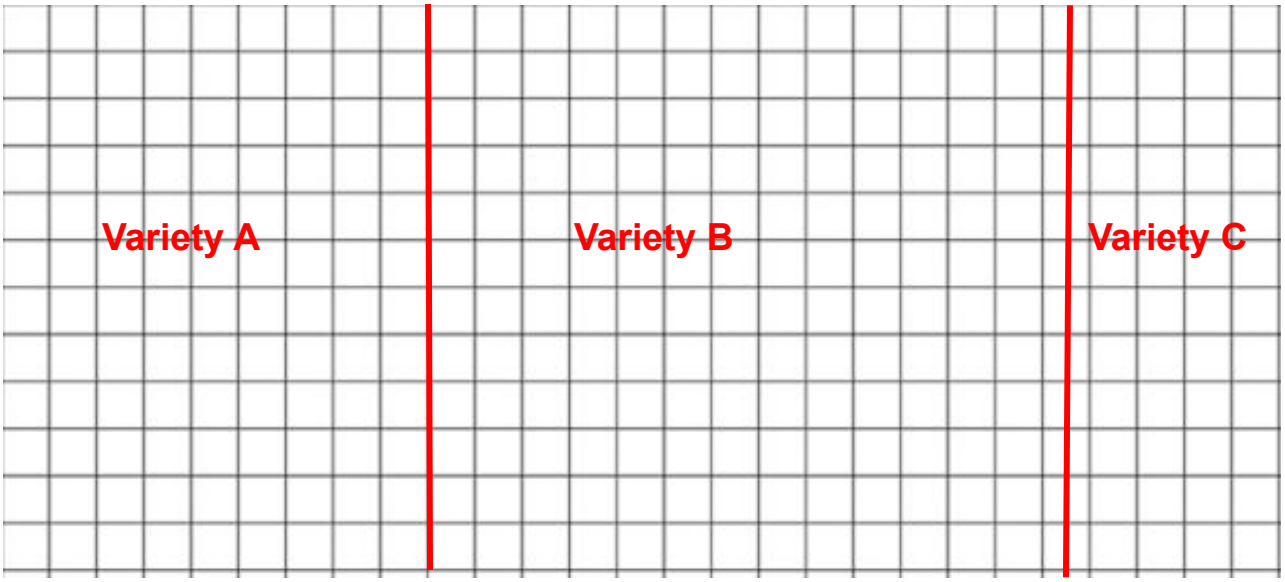
Corn Field and Math Science

Activity 1 Worksheet 2: Cornfield Math (continued) ANSWER KEY

Name: _____ Date: _____

Use your calculator and other mathematical tools to solve the following problems.

7. The farmer decided to plant 320 acres in three different varieties of corn. Use graph paper to construct a model of the farmer's land. Label each section, and complete the calculations. Show your work.



Discuss your work on this question with a partner or in a cooperative group.

a) Variety A produces one ear per plant. the farmer planted 1/3 of his 320 acres in Variety A. How many bushels of corn should Variety A produce?

⅓ x 320 = 106.66 acres x 135 bushels = 14,399.1 bushels

b) Variety B produces two ears per plant. the farmer planted half of his 320 acres in Variety B. How many bushels of corn should Variety B produce?

½ x 320 = 160 acres x 270 bushels = 43,200 bushels

c) Variety C produces 1.5 ears per plant. The farmer planted the rest of his acreage in Variety C. How many bushels of corn should Variety C produce?

(1 - ⅓ - ½) x 320 = 53.33 acres x (135 x 1.5) = 10,799.325 bushels

d) What is the total yield the farmer can expect for the entire 320 acres?

14,399.1 + 43,200 + 10,799.325 = 68,398.425 bushels

e) How much would the farmer receive from the sale of the corn at $2.40 a bushel?

68,398.425 x $2.40 = $164,156.22

f) The price of grain goes up and down on a regular basis. Use the internet to find the price of corn today $_____. At that price, how much would the farmer receive from the sale?

68,398.425 x $ today's price = $

Activity 2: Corn Field Math and Science,
(Social Studies, Science, Plant Science, Food Science & Technology) 1 50 minute class period

Students will learn about the history of corn and how crops have improved through chance breeding and through human modification

Oklahoma Academic Standards

Activity 2: Corn Field Math and Science (Social Studies, Science, Plant Science, Food Science & Technology)

SS 6.4.2	Evaluate the effects of human modification on the natural environment through transformation caused by subsistence and commercial agriculture, industry, demand for energy and urbanization
SS 7.4.4	Evaluate the effects of human modification of and adaptation to the natural environment through transformation caused by agriculture, the use of modern irrigation methods, industry, demand for energy, and urbanization.
7.LS2.1	Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
8.LS1.4	Use arguments based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively
8.LS1.5	Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.
8.LS.3.1	Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.
8.LS3.2	Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.
8.LS4.2	Apply scientific ideas to construct an explanation for the patterns of anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer ancestral relationships.
8.LS4.4	Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.
8.LS4.5	Gather and synthesize information about the practices that have changed the way humans influence the inheritance of desired traits in organisms
FPP.01.01.01.a	Discuss the history and describe and explain the components (eg. processing, distribution, byproducts) of the food products and processing industry
PS.03.01.01.a	Explain pollination, cross-pollination and self-pollination of flowering plants
BS.03.03.01.a	Describe the selective plant breeding process.

Materials:

- Activity 2, Reading page "**History of Corn"**
- Activity 2, Reading page "**How Hybrid Corn is Developed"**
- Internet access for video: **Popped Secret: *The Mysterious Origin of Corn***
- https://www.biointeractive.org/classroom-resources/popped-secret-mysterious-origin-corn
- Activity 2, Worksheet 3 "**Origin of Corn"**

Procedures

1. Read and discuss the reading page "**History of Corn"**
2. Watch the video **Popped Secret: *The Mysterious Origin of Corn***
3. Discuss the main points of the video including:
   How Dr. Beadle determined that teosinte was an ancient ancestor of corn and how archeology and genetics helped determine when corn was first domesticated
4. Read and discuss the reading page: **How Hybrid Corn is Developed**
5. How is current hybrid seed production is similar to and different from what ancient farmers did?
6. How can two varieties can combine to form corn that has more desirable traits than either parent plant?
   What would happen if you saved seed from hybrid corn and planted it?
   Would it have the same characteristics as the parent plant?
7. Have students complete Worksheet 1 "**Origin of Corn"**

Since ancient times, corn has played an integral role in human history. Corn developed from teosinte, a member of the grass family, and it is native to the Americas. There are many varieties of teosinte that still grow today, but the most genetically similar variety originated has been traced to southwestern Mexico. Tiny ears of corn have been discovered at ancient village sites and in tombs of early Native Americans. Evidence of corn in central Mexico suggests it was used there as long as 9,000 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). 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.

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 of the cob and heat popcorn kernels for a tasty snack.

Dent corn (also called field corn) is 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 are used as a soft-grit abrasive and to provide furfural, a liquid required in the manufacturing of nylon fibers. Corn is also 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.

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.

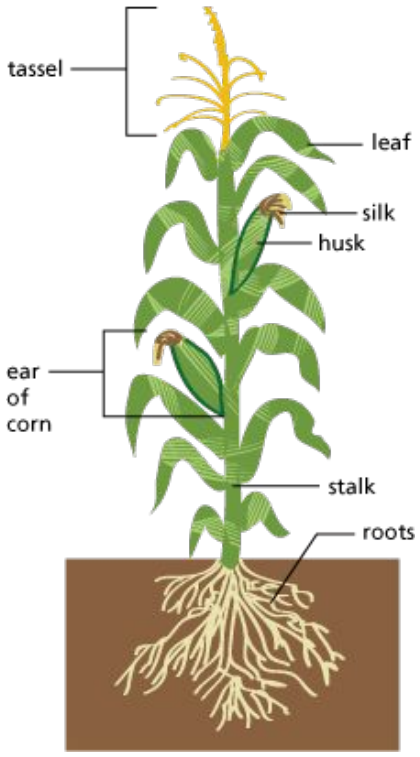
In general, hybrid corn varieties produce one to two ears per plant. If each plant produces at least one ear of corn, the yield will be 13,000,000 (thirteen million) kernels of corn from that single acre. A 400-acre farm would then yield over five billion kernels. In addition, consider that US corn yields 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. From foods of the past to fuels of the future, this highly diverse crop has played a major role in human civilization.

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.

To understand how a new hybrid variety is developed, we need a basic understanding of corn pollination and breeding.

The corn plant has separate male and female flowering parts:

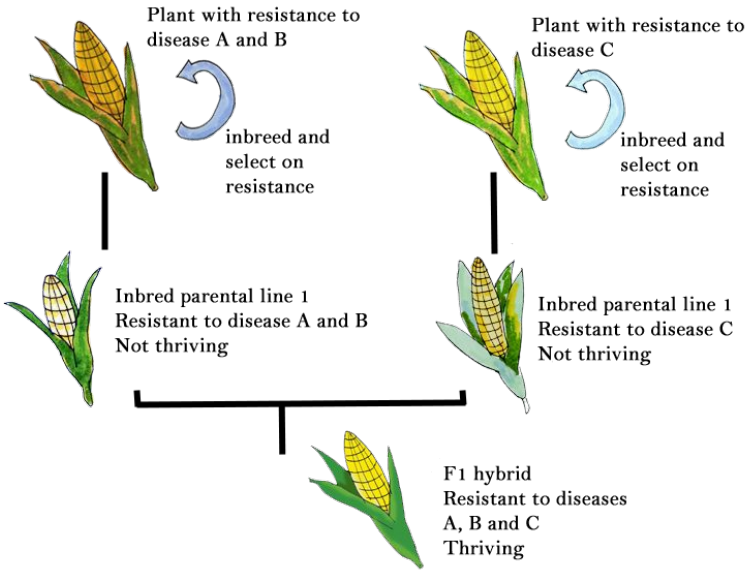
- the tassel is the male flower and produces pollen
- the ear is the female flower



With its separate male and female flowering parts, without intervention, corn will naturally cross pollinate. This means that ovules can be pollinated by pollen from nearby plants as well as the same plant..

Between 1850 and 1910, North American corn breeders developed higher yielding corn varieties by open or cross pollination. When more than one variety was planted in the field, each ear was a combination of cross and self pollinated kernels. Ears from the strongest plants were kept to use as seed the following year. As yields began to plateau and in the 1920's, scientists began to experiment with self-pollinating (inbreeding) corn varieties with desirable traits (large ears, disease resistance, drought tolerance, etc.). Once pure lines are established, scientists experimentally combine these inbred varieties to have more control over the process.

It takes about six generations of breeding (six growing seasons) to produce a pure inbred line of corn. At that point, plant scientists begin to experiment with cross pollinating seeds from pure lines to determine the best combination of traits for the end use. For example, one ear per stalk, at the same height on each stalk would be desirable in corn that will be mechanically harvested.



Once a daughter plant consistently exhibits the desired traits, seed is produced by removing the tassels from the plants that will produce seed, so that only the desired pollen will fertilize the ears of corn. The seed crop resulting from this process is called an **F1 (first generation) hybrid.**

This process must be repeated for each hybrid seed crop. To insure that each season's seed crop is pure, fields must be isolated from each other by at least 600 feet.

The pure genetic lines used to produce hybrid corn must also be maintained each year by hand pollinating to avoid contamination of the parent stock.

Source: Farmwest.com
Lana Reid, Agriculture and Agri-Food Canada Research Scientist, Ottawa Research and Development Centre

Corn Field and Math Science

Activity 2 Worksheet 1: The Origin of Corn

Name: _____ Date: _____

After watching **Popped Secret: *The Mysterious Origin of Corn***, answer the following questions. https://www.biointeractive.org/classroom-resources/popped-secret-mysterious-origin-corn

1. Circle the letter of the statement which describes domestication?
   a. The process by which animals are trained to do tricks useful for human needs
   b. The process by which wild species have been turned into species with traits that are useful for human needs
   c. The process by which animals build nests to attract mates and raise young
   d. The process by which plants have evolved to fill in ecological niches over time
2. List at least 5 ways corn is consumed in the American diet

3. The film mentions corn's role in meat, poultry and egg production. Explain the connection

4. The researcher, Dr. Beadle concluded that teosinte was the likely ancestor of corn. On what evidence did he base that conclusion? Circle all that apply.
   a. Teosinte looks like maize
   b. Teosinte and maize have nearly identical chromosomes
   c. A cross between teosinte and maize produces fertile hybrid offspring
   d. Christopher Columbus discovered written records of maize's domestication from teosinte.
5. Use the table below to compare teosinte and corn

	Branching	Number of rows of kernels per cob	Kernel type (naked or encased in hard shell)
Teosinte			
Corn (Maize)			

6. Pick one of the characteristics of corn from the table and explain how it makes the crop more useful to human civilization than teosinte.

7. The film describes two independent sources of evidence that have been used to estimate when maize was first domesticated: genetic evidence and archaeological evidence. Do these two sources support each other? Explain your answer.

Corn Field and Math Science

Activity 2 Worksheet 1: The Origin of Corn **ANSWER KEY**

Name: _____ Date: _____

After watching **Popped Secret: *The Mysterious Origin of Corn***, answer the following questions. https://www.biointeractive.org/classroom-resources/popped-secret-mysterious-origin-corn

1. Circle the letter of the statement which describes domestication?
   a. The process by which animals are trained to do tricks useful for human needs
   b. The process by which wild species have been turned into species with traits that are useful for human needs
   c. The process by which animals build nests to attract mates and raise young
   d. The process by which plants have evolved to fill in ecological niches over time
2. List at least 5 ways corn is consumed in the American diet
   As a vegetable (sweet corn), tortilla or corn chips, tortillas, corn flakes and other corn based cereals, as a sweetener (corn syrup), as oil (corn oil), as a thickener/binder (cornstarch), as a digestive/metabolic component in meat, poultry and egg products.
3. The film mentions corn's role in meat, poultry and egg production. Explain the connection
   Corn is a component in most animal feed, either the the form of grain mixed with other components or the entire plant, in the case of silage.
4. The researcher, Dr. Beadle concluded that teosinte was the likely ancestor of corn. On what evidence did he base that conclusion? Circle all that apply.
   a. Teosinte looks like maize
   b. Teosinte and maize have nearly identical chromosomes
   c. A cross between teosinte and maize produces fertile hybrid offspring
   d. Christopher Columbus discovered written records of maize's domestication from teosinte.
5. Use the table below to compare teosinte and corn

	Branching	Number of kernels per cob	Kernel type (naked or encased in hard shell)
Teosinte	Many branches	Fewer than 20	Encased in hard shell
Corn (Maize)	One central stem	Average of 600	Naked - protected by husks

6. Pick one of the characteristics of corn from the table and explain how it makes the crop more useful to human civilization than teosinte. Two characteristics make corn more useful. The large number of kernels per cob and easy access to the kernels. However, the hard shell would have protected the kernel and helped teosinte survive in the wild.

7. With its hard shell, how did indigineous people in Mexico find a way to use teosinte as food?
   Researchers learned that, like modern popcorn, the hard shells would pop when teosinte is heated. It is educated guess that the stalks were fed into a fire or roasted and when exposed to enough heat, the hard shell popped, exposing the tender and nutrient dense center.

Activity 3: Corn Field Math and Science (Science) 1-2 50 minute class periods

Students will learn how corn is processed, Students will experiment with and classify **Newtonian** and **Non-Newtonian** substances and use cornstarch to make Oobleck, a non-Newtonian Fluid

Oklahoma Academic Standards

Activity 3: Corn Field Math and Science (Science)

6.PS1.4	Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.
7.PS1.2	Analyze and interpret patterns of data related to the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.
7.PS1.3	Gather and make sense of information to describe that synthetic materials come from natural resources and impact society

Materials:

- corn starch (½ cup per group)
- zipper bags
- small plastic cups
- water
- Popsicle sticks
- Disposable plates and bowls
- Activity 3, Reading Page "**Corn Processing"**
- Activity 3, Reading Page "**What are Polymers?"**
- Activity 3, Worksheet 1 "**What is Oobleck?"**

Substances to test	Tools needed
Alcohol	wire whip or mixer
Egg Whites	mixer, bowl, sugar
Heavy Cream	mixer, bowl
Jelly	plate, knife, bread
Ketchup (glass bottle)	plate or bowl
Mayonnaise	plate, knife, bread
Peanut butter	plate, knife, bread
Toothpaste	toothbrush
Wall Paint	paintbrush, cardboard
Water	wire whip or mixer

Procedures

1. Measure cornstarch and prepare work stations to make Oobleck
2. Ask if anyone has eaten a polymer today. Discuss foods that contain polymers (most fruits and vegetables contain cellulose and simple sugars; gluten provides the structure that holds bread together, cornstarch and or corn syrup give yogurt its creamy texture, etc.)
3. Ask if anyone is wearing a polymer (rubber soled shoes, cotton, rayon, nylon, microfiber, wool, silk, polyester, athletic fabrics that wick moisture, waterproof fabrics, etc.)
4. Ask if anyone used a polymer to cook with (non-stick pans, silicone and rubber scrapers, silicone baking mats and pans, etc.)
5. Were any polymers involved in transporting you to school? (tires on the bus, synthetic leather seats, the coating on leather upholstery, the stain-resistant coating in fabric upholstery, etc.)
6. Read and discuss the reading page, **Corn Processing**
7. Tell students that today's activity used cornstarch, one of the minor products that results from refining corn
8. Read and discuss the reading page, **What are Polymers?**

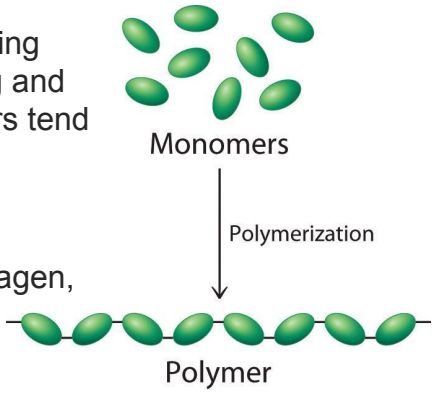
9. Hand out the worksheet, **What is Oobleck?**
10. Have students brainstorm and discuss properties of liquids and solids and record answers.
11. Properties of liquids include:
    a. Liquids have definite volume, but indefinite shape.
    b. When a liquid is inside a container, it will take its shape. If you take 100 ml of water, pour water in a cup, it will take the shape of the cup. Now pour the liquid from cup to a bottle, the liquid has changed its shape and now it has taken the shape of bottle.
    c. They are free to form droplets and puddles when they are not inside a container.
    d. Unlike gases, a liquid will not change its volume completely as it fills a container.
    e. Liquids are almost incompressible. In liquids, molecules are pretty close to each other. The molecules can not squeezed closer to one another.
    f. Liquids flow from higher to lower level.
    g. Liquids have their boiling points above room temperature, under normal conditions.
12. Properties of solids include:
    a. A solid has a definite shape and volume.
    b. Solids in general have higher density than liquids or gasses. Ice is an exception - water expands as it freezes and becomes less dense than the original substance
    c. In solids, intermolecular forces are strong.
    d. Diffusion of a solid into another solid is extremely slow.
    e. Solids have high melting points.
    f. Aside from the regular arrangement of particles, crystalline solids have several other characteristic properties. They are generally incompressible, meaning they cannot be compressed into smaller shapes. Because of the repeating geometric structure of the crystal, all the bonds between the particles have equal strength. This means that a crystalline solid will have a distinct melting point, because applying heat will break all the bonds at the same time
13. Provide materials to make Oobleck.
14. Based on the ingredients provided, students will hypothesize if they will be creating a solid or a liquid. Students will write their hypothesis on the worksheets
15. Students will work in pairs to make Oobleck, as described on the worksheet
16. Students will experiment with the Oobleck before answering the questions on the worksheet and recording their answers.

EXPLAIN: Oobleck is a non-Newtonian fluid. That is, it acts like a liquid when being poured, but like a solid when a force is acting on it. You can grab it and then it will ooze out of your hands. Make enough Oobleck and you can even walk on it!

Other substances have non-newtonian traits. Have students research the substances on the second page of the worksheet and complete the chart. The website below may provide some insight.

https://cravingsofafoodscientist.com/2019/04/17/the-unlikely-physics-of-ketchup-an-introduction-to-non-newtonian-fluids/

To learn more about the behavior of non-Newtonian fluids, watch the following short videos:
Non-Newtonian pothole fillers (1 min): http://youtu.be/XrvzZewPUJA
Oobleck on speakers (1.5 min): http://youtu.be/3zoTKXXNQIU
Walking on oobleck (20 sec): http://youtu.be/bIOGL4eZnjs
Sinking in oobleck (40 sec): http://youtu.be/Lb9kt1z3jAA
Time Warp high-speed (6 min): http://youtu.be/S5SGiwS5L6I



A **polymer** is a large **molecule** made up of chains or rings of linked repeating subunits, which are called **monomers**. Polymers usually have high melting and boiling points. Because the molecules consist of many monomers, polymers tend to have high molecular masses.

Polymers may be divided into two categories.

Natural polymers include silk, rubber, cellulose, wool, amber, keratin, collagen, starch, DNA, and shellac. Natural polymers serve key functions in organisms, acting as structural proteins, functional proteins, nucleic acids, structural polysaccharides, and energy storage molecules.

Humans have manipulated natural polymers throughout history. They learned that starch would thicken when heated and used it in a variety of recipes. The starch in water from cooking corn, potatoes, rice and tapioca could be used to stiffen fabrics. Silk, wool and cotton could be spun into thread and woven into fabric for clothing.

Synthetic polymers are prepared by a chemical reaction, often in a lab. Examples of synthetic polymers include PVC (polyvinyl chloride), polystyrene (Styrofoam®), synthetic rubber, silicone, polyethylene, neoprene, and nylon. Synthetic polymers are used to make plastics, adhesives, paints, mechanical parts, and many common objects.

British and American chemists learned that adding sulphur to rubber as it was heated (called vulcanizing) helped keep rubber from becoming sticky. The process was patented by British Engineer Thomas Hancock in 1843 and American chemist Charles Goodyear in 1844.

Plastic from corn?

While there are several plant sources of starch that can be used to make polymers, cornstarch is one of the most readily available since it is one the end products from processing corn.

Polylactic acid (PLA), a plastic substitute made from fermented plant starch (usually corn) is an alternative to traditional petroleum-based plastics. Since some municipalities discourage the use of plastic grocery bags, PLA seems to be a viable, biodegradable alternative.

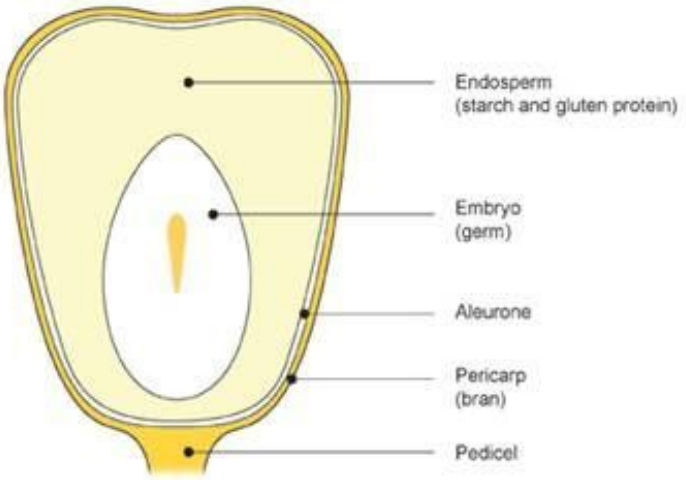
Those in favor of using PLA, (which is considered “carbon neutral” because it comes from renewable, carbon-absorbing plants) believe it is a way to reduce emissions of greenhouse gases. PLA also does not emit toxic fumes when incinerated. PLA is promoted as being biodegradable, but in reality it is compostable.

Industries using PLA cite faster decomposition with the same level of sanitation and utility as petroleum based plastics as the main reason for the switch. On the production end, it takes 4,000 gallons of water to grow a bushel of corn. Since water is a finite (but renewable through the water cycle) resource, growing corn to make plastic may not always be the best environmental choice.

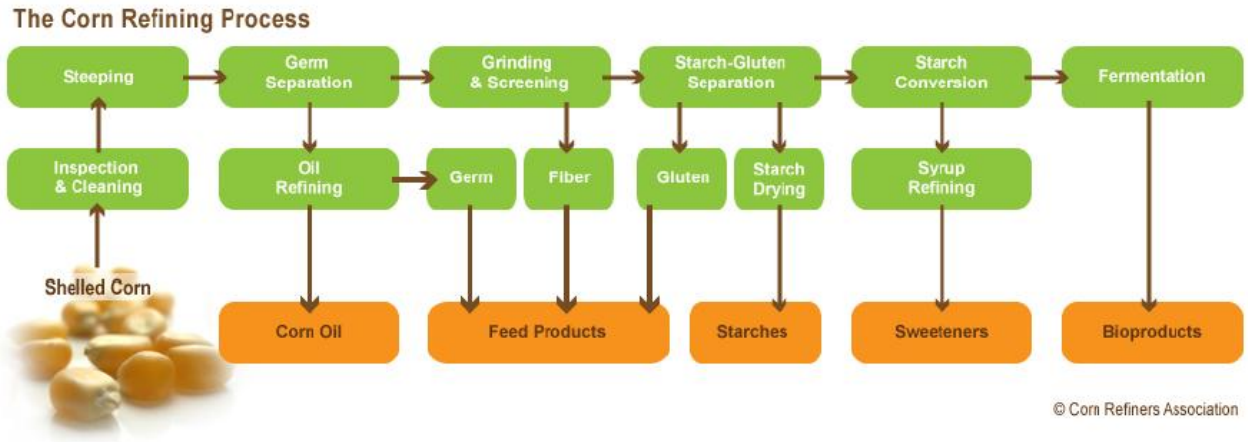
Sources:
Helmenstine, Anne Marie, Ph.D. "What Is a Polymer?" ThoughtCo, Aug. 27, 2020, thoughtco.com/definition-of-polymer-605912.
West, Larry. "Pros and Cons of PLA: Corn-Based Plastic." ThoughtCo, Aug. 26, 2020, thoughtco.com/pros-cons-corn-based-plastic-pla-1203953.

Corn Processing

Corn is processed using either a dry-grind or wet milling process. Dry-grind plants can only make ethanol (2.8 gallons per bushel). Other by-products include carbon dioxide, distiller grains, distillers soluble, and distillers grains with solubles.



Wet milling, as the diagram below shows, begins by steeping the corn for up to two days. From there it goes through a variety of grinding and separating processes to create the products farmers and consumers depend on.



A bushel of corn (about 56 lbs) produces three primary products after wet milling:

- corn oil (1.6 pounds) used for cooking oil, margarine, mayonnaise, salad dressing, shortening, soups, printing ink, soap, and leather tanning
- 21% corn protein gluten feed (13.5 pounds) used for livestock and poultry feed along with pet food
- 60% corn gluten meal (2.6 pounds) used for pre-emergence herbicide, poultry feed, and fur cleaner

The remaining starch can then be used to produce **one** of three alternatives:

- 33 pounds of corn sweetener used in a variety of food and beverage products
- 32 pounds of cornstarch used in products such as adhesives, batteries, cardboard, crayons, degradable plastics, dyes, plywood, paper, antibiotics, chewing gum
- 2.5 to 2.7 gallons of ethanol or alcohol used for motor fuel additive, alcoholic beverages, industrial alcohol

Sources: High Fructose Corn Syrup – How sweet it is; Ruth Litchfield, Ph.D., R.D., L.D., State Nutrition and Wellness Specialist, Iowa State University Extension and Outreach. May 2019.

The Corn Refiners Association: https://corn.org/

Corn Field Math and Science

Activity 3 Worksheet 1: What is Oobleck?

Name: _____ Date: _____

We usually think of materials around us as being a solid, a liquid or a gas. To prepare for this activity, list the properties of liquids and solids in the table below.

Properties of Liquids	Properties of Solids
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.

Oobleck gets its name from the Dr. Seuss book *Bartholomew and the Oobleck*. In the story, a gooey green substance, Oobleck, falls from the sky and wreaks havoc in the kingdom. Work with a partner to make Oobleck.

- Place ½ cup cornstarch in a plastic zip-top bag
- Slowly mix the water into the corn starch a little at a time until you get a gooey mixture. It should feel like a liquid (check your list above) when mixed slowly.
- Oobleck is done when it is no longer powdery, but doesn't splash when hit with a spoon.
- Use the list you made above to test whether oobleck behaves like a solid or a liquid. It may be helpful to test a bowl of plain water and something like a wooden block for comparison.

I think oobleck is a (liquid or solid) _____

Test your hypothesis (use the questions below or design your own experiments)

1. Can you pour it? _____What happens when you drop something into it? _____
2. Can you roll it into a ball? _____ If so, set the ball on a plate and see how long it takes to spread out and record the time._____
3. Will the ball bounce on the table? _____(Do not bounce on the floor)
4. What happens when you push an object (popsicle stick, finger, spoon, etc.) into it?
5. What happens when you stir it slowly?
6. What happens when you stir it quickly?
7. What happens when you pour oobleck into various shaped containers?

Corn Field Math and Science

Activity 3 Worksheet 1: What is Oobleck? (continued)

Name: _____ Date: _____

After testing oobleck, compare your results to your list of properties of liquids and solids.

Does oobleck behave like a liquid, a solid or both? _____

Fluids that exhibit no change in **viscosity** under stress (shear strain) are known as **Newtonian Fluids.** Substances that get thicker or thinner as the rate of stress (shear strain) increases are known as **non-Newtonian fluids**. Substances can exhibit properties of both solids and liquids, depending on the amount of stress or "shear" (how fast you try to move the substance) that is applied.

Test these substances and use the table to mark how the substance responds to stress or friction.

Substance	Gets thicker under stress	Gets thinner under stress	No change
Alcohol			
Egg Whites			
Heavy Cream			
Jelly			
Ketchup			
Mayonnaise			
Peanut butter			
Toothpaste			
Wall paint			
Water			

To learn more about the behavior of non-Newtonian fluids, watch the following short videos:

a. Non-Newtonian pothole fillers (1 min): http://youtu.be/XrvzZewPUJA
b. Oobleck on speakers (1.5 min): http://youtu.be/3zoTKXXNQIU
c. Walking on oobleck (20 sec): http://youtu.be/bIOGL4eZnjs
d. Sinking in oobleck (40 sec): http://youtu.be/Lb9kt1z3jAA
e. Time Warp high-speed (6 min): http://youtu.be/S5SGiwS5L6I

Corn Field Math and Science

Activity 3 Worksheet 1: What is Oobleck? ANSWER KEY

Name: _____ Date: _____

We usually think of materials around us as being a solid, a liquid or a gas. To prepare for this activity, list the properties of liquids and solids in the table below.

Properties of Liquids	Properties of Solids
1. It takes the shape of the container; the volume stays the same, even if the shape changes 2. It can pour, splash, spray, form droplets and puddles 3. Can freeze or boil (become either solid or gas at the right temperature) 4. Naturally flows from higher to lower level 5. Mixes easily with other liquids and can dissolve some solids	1. Have a definite shape 2. Have a definite volume 3. Does not combine easily with other solids 4. Generally has a high melting temperature 5. Bonds between molecules are strong, creating a rigid structure

Oobleck gets its name from the Dr. Seuss book *Bartholomew and the Oobleck*. In the story, a gooey green substance, Oobleck, falls from the sky and wreaks havoc in the kingdom. Work with a partner to make Oobleck.

- Place ½ cup cornstarch in a plastic zip-top bag
- Slowly mix the water into the corn starch a little at a time until you get a gooey mixture. It should feel like a liquid (check your list above) when mixed slowly.
- Oobleck is done when it is no longer powdery, but doesn't splash when hit with a spoon.
- Use the list you made above to test whether oobleck behaves like a solid or a liquid. It may be helpful to test a bowl of plain water and something like a wooden block for comparison.

I think oobleck is a (liquid or solid) _____

Test your hypothesis (use the questions below or design your own experiments)

1. Can you pour it? _____What happens when you drop something into it? _____
2. Can you roll it into a ball? _____ If so, set the ball on a plate and see how long it takes to spread out and record the time._____
3. Will the ball bounce on the table? _____(Do not bounce on the floor)
4. What happens when you push an object (popsicle stick, finger, spoon, etc.) into it?
5. What happens when you stir it slowly?
6. What happens when you stir it quickly?
7. What happens when you pour oobleck into various shaped containers?

Corn Field Math and Science

Activity 3 Worksheet 1: What is Oobleck? (continued) ANSWER KEY

Name: _____ Date: _____

After testing oobleck, compare your results to your list of properties of liquids and solids.

Does oobleck behave like a liquid, a solid or both? _____

Fluids that exhibit no change in **viscosity** under stress (shear strain) are known as **Newtonian Fluids.** Substances that get thicker or thinner as the rate of stress (shear strain) increases are known as **non-Newtonian fluids**. Substances can exhibit properties of both solids and liquids, depending on the amount of stress or "shear" (how fast you try to move the substance) that is applied.

Test these substances and use the table to mark how the substance responds to stress or friction.

Substance	Gets thicker under stress	Gets thinner under stress	No change
Alcohol			Not affected by stress Minimally affected by temperature
Egg Whites	Thicken when whipped with sugar to make meringue. Must be baked (chemical change) to hold shape. Otherwise, will lose volume and go back to original shape.		
Heavy Cream	Thickens when whipped to become whipped cream. Continued whipping makes butter		
Jelly		Jel holds shape, but spreads easily with knife	
Ketchup		Flows only after shaking bottle (or squeezing plastic bottle	
Mayonnaise		Firm but thins easily when spread	
Peanut butter		Solid in jar, but spreads easily on bread. Must be measured like shortening when cooking.	
Toothpaste		Semi-solid that thins with friction	
Wall paint		Designed not to drip, but thins when roller/brush applied to surface	
Water			Temperature causes change in density, but not stress

Activities 4: Corn Field Math and Science, (ELA, Science) 1 50 minute class period

Students will learn about physical and chemical changes in corn when heat is applied, Students will evaluate information about corn in popular media for accuracy

Oklahoma Academic Standards

Activities 4: Corn Field Math and Science (ELA, Science)

6.6.R.3 7.6.R.3 8.6.R.3	Students will determine the relevance, reliability and validity of the information gathered.
6.PS1.4	Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.
7.PS1.2	Analyze and interpret patterns of data related to the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.
7.PS1.3	Gather and make sense of information to describe that synthetic materials come from natural resources and impact society

Materials:

- Activity 2, Reading Page "**History of Corn"**
- Activity 3, Reading Page "**What is a Polymer?"**
- Activity 4, Reading Page "**Common Items Containing Corn"**
- Hot plate or other heat source
- Heavy 3 quart pan with see through lid (for popcorn)
- Heavy 2 quart pan (for polymer syrup)
- Large mixing bowl (for mixing popcorn balls)
- Large metal spoon (for mixing popcorn balls)
- Large wooden or silicone spoon (for stirring caramel mixture while heating)
- Timer or cell phone for timing

The same pan can be used for popping corn and making syrup if you are able to wash the pan between tasks.

Can also use an air popper so students can observe physical change in popcorn.

Ingredients for Popcorn Ball Polymers (makes 12 popcorn balls)

1/2 cup corn syrup
1 cup sugar
1/4 cup butter
1/2 teaspoon salt
1 teaspoon vanilla
1/2 teaspoon baking soda
3 quarts (12 cups) warm popped corn
3 tablespoons vegetable oil
⅓ cup popcorn kernels

Waxed paper or parchment
Clean kitchen towel or wide foil
Non-stick cooking spray
Dishwashing liquid

It may be necessary to pop two batches of popcorn to reach 12 cups.

Procedures

1. Assemble and measure all ingredients before beginning.
2. Pop the popcorn using the instructions on the worksheet. You may need to make two batches so that all students have a chance to see the corn pop.
3. Discuss the physical changes in the corn when it pops. *Heat causes the molecules inside the kernel to move faster and expand, creating steam. The steam eventually creates enough pressure for the kernel to explode.* Alternatively, use an air popper so students can observe physical change in the popcorn.
4. Before making the syrup for the popcorn balls, explain the role of corn syrup in making candy. *Corn syrup is an invert sugar, which means that it prevents sugar crystals from forming. Microscopically, sugar has jagged edges and when you melt it, sugar liquefies. But if you keep cooking it to a syrup, those jagged edges want to re-attach themselves to others, forming crystals. Corn syrup acts as* interfering agent, *which emulsifies the sugar (keeps the sugar crystals in suspension). Honey, agave, and other liquid sweeteners, don't have the same properties. Corn syrup also contributes to the glossy surface of candies.*
5. Grease a large mixing bowl and add popped popcorn. Cover with a clean towel or foil to keep warm while you make the syrup.
6. Grease a large mixing spoon and set aside.
7. Combine sugar, corn syrup, butter and salt in a heavy 2-quart saucepan.
8. Stirring constantly, bring to a boil over medium heat. Continue stirring and boil 2 minutes.
9. Remove syrup mixture from heat; stir in vanilla and baking soda.
10. Pour syrup over popcorn, stirring to coat well.
11. Let the mixture cool a little while students wash their hands then coat their hands lightly with non-stick cooking spray or oil. Cooling is important - the syrup needs to become tacky for the balls to stick together.
12. Students will work quickly to press the popcorn into balls to make "popcorn polymers."
13. Cool popcorn balls completely on waxed paper or parchment before eating.

Corn is part of almost every facet of our lives - from toothpaste to diapers to foods to the fuel for our cars. There are both facts and misinformation about corn and its many products circulating in popular media. Have students research the statements on **Worksheet 2** to determine whether the statement is a fact or myth and justify their answers beneath the statement. Some of the information can be found in the reading page, **Common Items Containing Corn**, but additional research is necessary for some.

Additional Reading:

Dunford, Nurhan, *Diesel Fuels Derived from Renewable Sources,* FAPC-177, July 2019, http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-8279/FAPC-177web.pdf

Litchfield, Ruth, *High Fructose Corn Syrup - How Sweet it is*, Iowa State University Extension and Outreach Fact Sheet, May 2019 https://lib.dr.iastate.edu/extension_families_pubs/23/

Renewable Fuels Association, https://ethanolrfa.org/how-ethanol-is-made/

Corn Field Math and Science

Activity 4 Worksheet 1: Popcorn Ball Polymers

Name: _____ Date: _____

A polymer is formed when several small molecules (monomers) combine. It consists of repeating structural units. Students will create their own models of polymers by making popcorn balls.

Popcorn
3 Tablespoons vegetable or coconut oil
⅓ cup popcorn kernels
Salt if desired

Polymer Syrup
1/2 cup corn syrup
1 cup sugar
1/4 cup butter
1/2 teaspoon salt
1 teaspoon vanilla
1/2 teaspoon baking soda
3 quarts (12 cups) warm popped corn

Pop the Popcorn

1. Heat the oil in a 3-quart thick-bottomed saucepan on medium high heat. If you are using coconut oil, allow all of the solid oil to melt.
2. Put 3 or 4 popcorn kernels into the oil. Wait for the popcorn kernels to pop.
3. When the kernels pop, add the rest of the 1/3 cup of popcorn kernels in an even layer.
4. Cover the pot, remove from heat and count 30 seconds. This method first heats the oil to the right temperature, then waiting 30 seconds brings all of the other kernels to a near-popping temperature so when they are put back on the heat, they all pop at about the same time.
5. Return the pan to the heat. The popcorn should begin popping soon, and all at once. Once the popping starts in earnest, gently shake the pan by moving it back and forth over the burner.
6. Once the popping slows to several seconds between pops, remove the pan from the heat, remove the lid, and dump the popcorn immediately into greased bowl.

Make the polymer syrup

1. Combine sugar, corn syrup, butter and salt in a heavy 2-quart saucepan.
2. Grease a large mixing bowl and put in popped popcorn. Grease a mixing spoon. Set aside.
3. Combine corn syrup and sugar in a saucepan. Stirring constantly, bring to a boil over medium heat. Continue stirring and boil 2 minutes.
4. Remove syrup mixture from heat; stir in vanilla and baking soda.
5. Pour syrup over popcorn, stirring to coat well.
6. Let the mixture cool a little while students wash their hands then coat them lightly with non-stick cooking spray or oil.
7. Students will work quickly to press the popcorn into balls to make “popcorn polymers.”
8. Cool completely before eating.

Toothpaste: Sorbitol is an ingredient in toothpaste derived from corn. It helps create toothpaste's flavoring and texture.

Yogurt: Uses high-fructose corn syrup as a sweetener; the cows that make the milk also eat corn in their daily meals.

Chewing Gum: Uses high fructose corn syrup and maltitol as sweeteners and sorbitol for flavoring.

Cosmetics: Blush and eye shadow often contain zea mays, which is another name for corn.

Shampoo: Citric acid is a common ingredient in shampoos and conditioners and is derived from corn.

Diapers: Corn starch is used to soak up moisture in diapers.

Envelopes: Corn is used to make the glue, which holds envelopes closed.

Corn Bread: The main ingredient is corn meal, which gives cornbread its gritty texture.

Handsoap: At least 25% of the ingredients in some hand soaps were derived from corn.

Windex: This glass cleaner contains at least 5 different ingredients derived from corn.

Jellybeans and Licorice: These candies not only include corn syrup of some form to give them their texture but also, powdered corn starch is used to coat their molds and allows manufacturers to more easily pop them out after they're finished being molded.

Corn Flakes: If you enjoy a hearty bowl of flakes for breakfast, you're eating the corn grit that has been steamed and flaked**.**

Soft Drinks: many non-diet soft drinks are sweetened with High Fructose Corn Syrup.

Paper, Recycled Paper and Cardboard: Industrial corn starch is used in the papermaking process.

Crayons and Chalk: Utilize industrial corn starch to get them out of their molds and corn products also help the paper labels adhere to the crayons.

Source: Kansas Corn Growers Association

Running Shoes: Currently, most shoes are made with oil-based plastics, but Reebok has announced it will begin to make the sole of their new sustainable shoe with petroleum-free, industrial-grown corn.

Spark Plugs: Spark plugs in your car are made from metal and ceramics. When the crystalline structures of cornstarch are heated to very high temperatures, they harden and it becomes a type of ceramic. The ceramic is able to withstand high temperatures and also withstands the corrosive properties of some specific acids.

Rubber Tires: Instead of using oil-based rubber, Goodyear and their research partner Genencor are using cornstarch to chemically bind the ingredients of its new kind of tire.

Fireworks: Some of the compounds in fireworks require a "binder" in order to burn properly. A common binder is dextrin, a light carbohydrate most commonly made from corn.

Popcorn: Popcorn is its own type of corn. There are three common types of corn; sweet corn, popcorn and field corn. The two we eat in their natural form are sweet corn and popcorn.

Pet Food: Pet food is regulated to the same level of safety as human food. Corn is used in pet food to create a balanced diet for all kinds of pets including dogs, cats and even fish.

Batteries: Corn starch is often used as an electrical conductor in batteries. Deodorant: Uses corn starch because of its absorbent nature.

Hand Sanitizer: Contains ethanol which typically is made by fermenting corn.

Carpet and Other Textile Products: Corn-based textile products are often preferred to the petroleum based products because they are more environmentally friendly.

Plastic Products: While it's not a widespread use like the other products, bioplastic is being used in many different products such as bags, containers and cups. Corn-based plastics can be composted and use up to 68% less fossil fuels during production than traditional plastics and are estimated to emit 55% less greenhouse gases.

Source: Kansas Corn Growers Association

Corn Field Math and Science

Activity 4 Worksheet 2: Fact or Myth

Name: _____ Date: _____

Research the statements below to determine whether they are facts or myths. In the space below the statement, justify your answer.

Statement	Fact	Myth
Corn syrup helps prevent crystal formation in candies and other foods		
Most of the US corn crop is used to produce High Fructose Corn Syrup (HFCS)		
High Fructose Corn Syrup (HFCS) is higher in calories than plain sugar		
Ethanol production is increasing in the United States		
Corn is the only grain that can be used to make ethanol		
A 2-liter bottle of soda contains more corn than an 18 oz. box of corn flakes		
Plastic made from corn breaks down more quickly in a landfill than regular plastic		
Non-Newtonian fluids like oobleck can be used to make protective equipment for soldiers and police officers		

Corn Field Math and Science

Activity 4 Worksheet 2: Fact or Myth ANSWER KEY

Name: _____ Date: _____

Research the statements below to determine whether they are facts or myths. In the space below the statement, justify your answer

Statement	Fact	Myth
Corn syrup helps prevent crystal formation in candies and other foods Because corn syrup is an "invert sugar" it emulsifies solutions and prevents crystal formation in candies and icings	X	
Most of the US corn crop is used to produce High Fructose Corn Syrup (HFCS) 39% of all corn in the US is used for livestock feed, 27% is used to make ethanol, 16% is exported. Only 9% of corn grown in the US is processed for human consumption - either into oil, sweeteners, starch, flour/meal, etc.		X
High Fructose Corn Syrup (HFCS) is higher in calories than plain sugar All dietary sugars (corn syrup, sucrose, HFCS, and honey) have 4 calories/gram They are broken down a little differently in the body, but the net energy they provide is the same		X
Ethanol production is increasing in the United States Since 2005, the US has led the world in ethanol production. Production has increased from 13.2 billion gallons in 2010 to more than 16 billion gallons in 2019	X	
Corn is the only crop that can be used to make ethanol Corn is the most common substance for ethanol production in the US. However, throughout the world, other crops such as sugar cane (in Brazil) and sorghum (in Europe) are used. Current research includes fermenting cellulose (corn stalks and cobs, wheat straw, native grasses, waste from wood milling and waste from food processing, etc.) to make ethanol.		X
A 2-liter bottle of soda contains more corn than an 18 oz. box of corn flakes The amount of corn needed to make the corn syrup in a bottle of soda is 15 ounces compared to 12.9 ounces of corn to make a box of cornflakes.	X	
Plastic made from corn breaks down more quickly in a landfill than regular plastic Under the right circumstances, plastic made from corn breaks down in about 90 days. However it must be composted (exposed to heat, light and moisture) to achieve that result. In a landfill, the breakdown is similar to regular plastic.		X
Non-Newtonian fluids like oobleck can be used to make protective equipment for soldiers and police officers Protective clothing that is flexible when worn but hardens on impact is one of the most promising potential uses for non-Newtonian fluids	X	