History of Plant Breeding

How has the science of plant breeding changed over time?

Skill Level: Senior (14-18 years old) or 9-12th grade

Learner Outcomes:
Understands that over time, scientists have contributed to the body of knowledge that we have about plant breeding today.

Understands that the science of plant breeding has evolved over thousands of years.

Education Standard(s)
NSES: Life Sciences

Next Generation Sunshine State Standards: SC.912.N.2.5; SC.912.N.3.1; SS.912.E.2.3; SS.912.W.9.1

Success Indicator:
Can discuss how the science of plant breeding has changed over the course of history.

Life Skill(s): Cooperation, communication

Tags: plant breeding, hybrid, heredity

Time Needed: 60-90 minutes

Materials List: paper, pencil, newsprint or flipchart paper, poster board, markers, modeling clay, copies of History Cards and Activity Cards.

The history of agriculture is the history of mankind. The move from hunter-gatherer to agricultural societies was the first great leap towards today's civilization. In 8000 B.C.E. the first "plant breeders" domesticated wild plants by artificially selecting the best plants, harvesting the seed, and replanting it. Mankind was never the same again. The "leap", propelled by artificial plant selection launched us on the path to the technological society we are today. Wheat was one of the earliest crops to be domesticated, followed by barley, flax (a fiber), peas, and lentils. The rest is plant breeding history.

To understand history is to appreciate how any one event or development rarely has a single cause- or result. Each facet of human culture (social, technological, political) can be visualized as interconnected by rubber bands. As one part changes, it pulls the others along with it. If any or all parts do not move, the connecting rubber bands stretch as the distance between increases. If the distance becomes to great one (or more) rubber bands snap. Visualize the snap as dramatic change, such as a revolution. As you learn about the history of plant breeding, consider how one event affected another.

In the mid-1800s, a young Austrian monk named Gregor Mendel correctly noted that traits in pea plants were inherited. This was a new idea at the time; previously it was thought that the environment influenced traits. As an amateur scientist,

Learn More

Biological, Cultural and technological Evolution in History

http://www.flowofhistory.com/units/pre/1/FC1.

Virtual Fun

A Plant's Eye History of the World. An interactive site revealing the historical association of man and plants.

http://www.pbs.org/teachers/connect/resources/7493/preview/.

Mendel's simple breeding experiments with peas gave birth to the idea of *heredity*.

In the early 1900's, G.H Shull discovered that if he crossed two corn plants that are different, it resulted in a more stable corn varieties. These two stable breeding lines were then crossed resulting in *hybrid* corn. Hybrid breeding technology was soon adopted by breeders of other crops. Today, ninety percent of vegetable crops are grown as hybrids.

In the 1940s Dr. Borlaug began to breed a high yielding, disease resistant wheat to address Mexico's grain shortage. Mexico soon had enough wheat to feed the nation with a surplus to export to other countries.

Dr. McClintock studied mutation in the kernels of corn and was the first scientist to report "*jumping genes*". Before her discovery it was believed that genes remained on a specific portion of the chromosome. She noticed in Indian corn that some of these genes were *transposable*, meaning they could move from one gene to another.

The 1970s saw the first breakthroughs in recombinant DNA technology now known in plant breeding as *transgenic* breeding or breeding genetically modified (GM) crops. By taking a section of DNA from one organism and inserting it into a crop plant's DNA, geneticists were able to begin the next big step in plant breeding history, creating improved crops called transgenic crops. Compared to conventional breeding, transgenically bred crops contain traits not found in the species. The transgenic breeder has more control over what characteristics can be bred into a plant. Today plant breeders strive to create crop varieties that yield well on reduced inputs (such as water, fertilizer, and herbicides or pesticides). By the early 1990s the first commercial GM crops were planted. Today 85% to 91% of cotton, corn and soybean crops grown in the US are genetically modified.

What to Do:

Divide the class into 8 groups. Give each group a History Card and an Activity Card (found at the end of this lesson). Each group must complete the activity on the card using the information about plant breeding on their History Card and an Activity Card. For example, if a youth draws the *George Washington Carver History Card* and the *Time Travel Activity Card*, write a press release about how history or science might be different today that scientist or discovery had happened in a different time period.

Allow 15 minutes for the groups to prepare their presentation, then let each group present what they did to the entire group. Conclude with the processing questions at the end of this lesson.

Did You Know?
McClintock is the only woman ever to win an unshared Nobel Prize in the Medicine category.

Glossary Words
Heredity
Hybrid
Jumping genes
Transposable
Transgenic

TALK IT OVER:

Share. . .

- How did your group work together in order to accomplish the tasks you were given to learn about the history of plant breeding?
- Did everyone in the group agree on what to do? Did everyone in the group contribute something? If not, why?

Reflect. . .

- Why is it important to learn about how one event affects another?
- What did you learn from this activity that you didn't know before?

Generalize. . . .

- In what way do people help each other learn new things?
- Why is it important to know about the history of plant breeding?

Apply. . .

- How would you teach someone else about the history of plant breeding?
- How could the things you learned today help you in other situations at home or at school?

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History Cards

Early History of Plant Breeding (8,000 BC)

About 10,000 years ago, in an area known as the Fertile Crescent, mankind began its long history of agriculture. The Ice Age was ending, and human populations were growing. Until this time, people ate by hunting and gathering their food. Farming likely began in areas filled with animal dung, because people noticed seeds planted in these areas grew better, however these early crops bore little resemblance to those we see today. Enter the first plant breeders. These "plant breeders" domesticated wild plants by artificially selecting the best plants, harvesting the seed, and replanting it. A domesticated plant is one that has been artificially selected by humans. Artificial selection is practiced when humans collected seeds from stronger plants and replant them. Wheat was one of the earliest crops to be domesticated, followed by barley, flax (a fiber), peas and lentils.

Industrial Revolution (1700's)

Farming changed very little until the early 1700s when an agricultural revolution took place. In England, the seed drill was invented reducing the amount of seed wasted when planting while allowing farmers to sow seeds in straight rows and at specific depths. Crop rotation restored depleted soil nutrients and reduced the buildup of insects and pathogens in a field by growing dissimilar crop types in the same field in sequential seasons. Soil structure and fertility are balanced by planting heavy feeding crops like corn and following the next year with beans or a *green manure* crop. A green manure crop is one grown specifically to be plowed back into the soil thereby increasing soil quality and nutrients. These new farming techniques increased crop yields, which in turn created a small population boom. In this manner farming paved the way creating the additional manpower needed to stoke the wheels of the Industrial Revolution.

Mendel's Peas (1850's)

In the mid-1800s, a young Austrian priest and monk named Gregor Mendel began to experiment with breeding pea plants in the courtyard of the small abbey in which he taught. He correctly noted that traits in pea plants were inherited. This was a new idea at the time; previously it was thought that the environment (soil, water, sunlight, and weather) influenced traits. As an amateur scientist, Mendel's simple breeding experiments with peas gave birth to the idea of heredity. Heredity is the biological process whereby genetic factors are transmitted from one generation to the next. You will learn more about heredity in the genetics chapter. Mendel's discovery was ignored then lost, not to be rediscovered for almost 50 years.

Hybrid Corn (Early 1900's)

In 1906 G.H Shull began experiments on inheritance in corn. He discovered that if he crossed two corn plants that are different, it resulted in more stable corn varieties. These two stable breeding lines were then crossed resulting in *hybrid* corn. Mixing the genetics of two dissimilar corn types creates a *hybrid* or blending of the two parents' characteristics, but in a predictable way. By mixing the parents' genes, Schull's hybrids were stronger than their parents and higher yielding. Hybrid breeding technology was soon adopted by breeders of other crops. Coupled with advances in chemical fertilizer and pesticides, hybridization helped to boost crop yields to historic levels through the 1900s. Today, ninety percent of vegetable crops are grown as hybrids.

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George Washington Carver (1864-1943)

George Washington Carver overcame illness and slavery to become one of the most respected scientists of his time. Carver's new concept was *crop rotation* where cotton crops were alternated with peanut and field peas. Peanuts and peas are legumes, a type of plant that actually manufactures a crucial crop nutrient, nitrogen from the air. By rotating heavy feeding crops like cotton with peanuts, farmers not only had a second crop to sell or feed livestock, but legumes add soil nutrients, making the soil more productive. So successful were southern farmers with crop rotation that Carver was forced to find alternate uses for the huge amounts of peanuts, sweet potatoes and other crops realized in this soil-replenishing crop rotation. Carver discovered over 400 different products and uses from peanuts and sweet potato alone, including peanut butter! Carver felt his discoveries were best shared by all men and patented only three of his discoveries.

Wheat for the World (1940-1970's)

In the 1940s Dr. Borlaug began to breed a high yielding, disease resistant wheat to address Mexico's grain shortage. The country needed to import expensive wheat from other countries to feed its people. Borlaug's dwarf wheat plant yielded two to three times more than earlier varieties. Mexico soon had enough wheat to feed the nation with a surplus to export to other countries. Borlaug took his plant breeding skills to assist other developing nations, including India and Pakistan. Mexico took almost 15 years to become self-sufficient in feeding its nation; India only took three years. One wheat breeder saved millions of people from dying of starvation.

Jumping Genes (1950's)

Dr. Barbara McClintock (1902-1992) was one of the most prominent female scientists of the twentieth century. Her discovery in 1952 was so radical that her fellow scientists did not accept it until 20 years later. McClintock studied mutation in the kernels of corn and was the first scientist to report "jumping genes," but the technology did not exist at that time to prove it. At the time, it was believed that genes remained on a specific portion of the chromosome. She noticed in Indian corn that some of these genes (carrying traits) were transposable. Transposable genes could move not only on one gene but "jump" from one gene to another. She won the Nobel Peace Prize in Medicine in 1983. Her work was a driving force showing the increasing role genetics played in plant breeding. Her research paved the way for the biotechnical plant breeding and the genetically modified crop boom just ahead.

GMO's (1970's-Today)

The 1970s saw the first breakthroughs in recombinant DNA technology now known in plant breeding as transgenic breeding or breeding genetically modified (GM) crops. By taking a section of DNA from one organism and inserting it into a crop plant's DNA, geneticists were able to begin the next big step in plant breeding history. Compared to conventional breeding, transgenically bred crops contain traits not found in the species. The transgenic breeder has more control over what characteristics can be bred into a plant.

Today plant breeders strive to create crop varieties that need less water, fertilizer, and chemical pesticides. By the early 1990s the first commercial GM crops were planted. Today 85% or more of cotton, corn and soybean crops grown in the US are genetically modified.

Time Travel Think about the scientist or discovery on your History Card? Why was it important? How do you think the world would be different if this scientist had lived in a different time period? Write a short public service announcement (PSA) that is 60 seconds or less to explain this to the group.	**Role Model** Science has always influenced art. Without science, we wouldn't have wide varieties of ink or paint, or other artistic mediums. As a group, use the modeling clay to create a sculpture that represents the important discovery during the time period of your history card.
Tweet All About It Think about the scientist or discovery on your history card. Why was it important? As a group, write a "tweet" using 140 characters or less that summarizes why this discovery or innovation was important. Be prepared to share your tweet with the other groups and explain what it means to you.	**Technophobia?** Humankind has often been weary of new technologies, especially those that cannot easily be seen. Think "jumping genes" and GMOs (genetically modified organisms). What if these concepts had been discovered a hundred years from now? Write a jingle or a rap that explains how you think these technologies would be received 100 years from now. Be prepared to perform your song with the other groups and explain what it means to you.
Driven to Discover Think about the scientist or discovery on your history card. Why was it important? Using a piece of poster board and markers, design a vanity license plate for the scientist or discovery that describes an innovation in plant breeding on your history card. Be prepared to share your license plate with the other groups and explain what it means to you.	**Drawing Conclusions** Think about the scientist or discovery on your history card. Why was it important? Using a piece of newsprint or flipchart paper and markers, draw a group mural of what today's world would look like if that scientist or discovery had not been made. Be prepared to share your drawing with the other groups and explain what it means to you.
Bumper Stumper Think about the scientist or discovery on your history card. Why was it important? As a group, use a piece of poster board and markers, design a bumper sticker that captures why that discovery was important. Be prepared to share your design with the rest of the groups.	**Poetic License** Think about how discoveries in science have influenced our culture. For example, what if Alexander Graham Bell never invented the phone? Write a short poem about how the science or scientist on your history card has influenced today's culture. Be prepared to share your poem with the rest of the groups.