History of Plant Breeding

Skill Level: Intermediate (11-13 years old)

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

Education Standard(s)
NSES: Life Science, History and Nature of Science

Sunshine State Standards: SC6.N.1.5, SC6.N.2.3, SC7.N.2.1, SC7.L.16.1, SC7.L.16.4, SC.8.N.4.2, SS.6.W.2.1, SS.6.W.2.2, SS.8.A.4.6, SS.8.E.2.1, SS.8.E.2.3

Success Indicator: Can discuss how the science of plant breeding touches their everyday lives.

Life Skill(s): Decision making, cooperation, communication

Tags: plant breeding, hybrid, jumping genes, Mendel, Borlaug

Time Needed: 60-90 minutes

Materials List: pipe cleaners in assorted colors, paper, pencil, newspapers, masking or duct tape, poster board, glue stick, scissors, old magazines, markers, flip chart paper, paper or plastic cups, copies of History Cards, Activity Cards, and Carver Timeline Statements.

Who is known as the "Father" of modern day plant breeding?

The first "plant breeders" domesticated wild plants by artificially selecting the best plants, harvesting the seed, and replanting it. Wheat was one of the earliest crops to be domesticated, followed by barley, flax (a fiber), peas and lentils.

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, 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 self-pollinated two corn plants that were different, it resulted in more stable corn varieties. When these two stable breeding lines were crossed the result was *hybrid* corn. Corn hybrids are much more productive than their open-pollinated counterparts. 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 chromosome to another.

Learn More

History of Plant Breeding. http://cls.casa.colostate.edu/transgeniccrops/history.html.

Virtual Fun

Learn about Gregor Mendel and his famous peas by playing this game!

http://puzzling.caret.cam.ac.uk/game.php?game=15&age=1.

The 1970s saw the first breakthroughs in recombinant DNA technology. 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 made crops contain traits not found in the species. The 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 group up into seven 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. For example, if a youth draws the Jingle Card, and they have the Jumping Genes History Card, then they have to write a jingle about the Jumping Genes Discovery. Give the groups about 10 minutes to complete the task, and then allow each group to share in one large group.

Supplies Needed:

- *Take it to the Cleaners*- pipe cleaners in assorted colors
- *Jingle all the Way*- Paper and pencil
- *Creative Collage*- poster board, glue stick, scissors, old magazines or newspapers
- *Tweet All About it*- Paper and pencil
- *Driven Plants*- Paper and markers
- *Drawing Conclusions*- Flip chart paper or poster board and markers
- *News to You*- Paper and pencil

Next, ask the youth to share with the group what they know about George Washington Carver. Have a youth volunteer write down the statements on a whiteboard or newsprint paper. Use the statements to begin an informal discussion on Dr. Carver and his contributions to agriculture and science. Although Dr. Carver was not a plant breeder, his work with peanuts, sweet potatoes, pecans, and innovations in crop rotation contributed to rural economic development. Dr. Carver's contributions to agriculture boosted crop yields but plant breeders knew they could do better. Until the early 1900s most crop plants were *open pollinated*. Open pollinated crops like corn were left to pollinate in the field. The pollen source from unknown plants would pollinate a corn ear. The farmer would pick out the best looking or highest yielding ears for next year's seed but since the pollen was from many unknown plants, the offspring varied in their genetic traits. This next generation of planted seed would look and behave similarly to the plant it was harvested from, but not always. Hybridizing corn solved the problem.

Divide the youth up into groups of 2-3, and give each group a statement about Dr. Carver's life. Ask them to research Dr. Carver either online or in a library, or with books you have pre-selected. If using the Internet, you may want to review the

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

Glossary Words
Heredity
Hybrid
Hybrid vigor
Green manure crop
Jumping genes
Transposable
Transgenic
Open pollinated

Internet Research Checklist found in the previous lesson. Allow 15-20 minutes for youth to research Dr. Carver, then ask them to form a human timeline (without talking). Once the group is lined up, allow youth to justify why they lined up where they did. Some recommended websites include:

- The Legacy of GW Carver. http://www.lib.iastate.edu/spcl/gwc/bio.html.
- National Park Service American Visionaries: GW Carver. http://www.nps.gov/museum/exhibits/tuskegee/gwcoverview.htm.
- National Agricultural Library: George Washington Carver. http://www.nal.usda.gov/outreach/carver2.pdf

Lastly, give each student a paper cup and a permanent marker. Ask them to think about a discovery or scientist that had a major impact on plant breeding. Next, tell them to write a word or phrase that describes this discovery or scientist. Ask the students to turn their cups upside down and stack them up in a pyramid shape. When the pyramid is complete, ask them what would happen if you were to remove one of the discoveries/scientists? Obviously, unless you only removed the top cup, the pyramid would fall. Each of the discoveries contributed to the body of knowledge that we have today. Today's scientists are working to build knowledge for the future. This activity is a wonderful lead in to the processing questions for this lesson.

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?

Reflect. . .

- Why is it important to know about the history of plant breeding?

Generalize. . . .

- In what way do people help each other learn new things?

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?

References:

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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 helped increase crop yields, but little was being done in plant breeding. This was about to change thanks to a young monk tending his pea plants in a church abbey.

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 self-pollinated two corn plants that are different, it resulted in more stable corn varieties. When these two stable breeding lines were crossed the result was *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 and most corn is grown as hybrids.

Jumping Genes (1950's)

Dr. McClintock worked on corn genetics and proposed an idea so radical in 1952 that her fellow scientists did not accept it until 20 years later. Dr. McClintock studied mutation in the kernels of corn and was the first scientist to report "*jumping genes*". Until 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 (carrying traits) were *transposable*. Transposable genes or transposons could move from one place on the chromosome to another. Because this discovery had such wide implications in genetics, she went on to win the Nobel Peace Prize in Medicine in 1983.

Wheat for the World (1940'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. One wheat breeder saved millions of people from dying of starvation. For his work, Dr. Borlaug was awarded the Nobel Peace Prize in 1970.

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 yield well with less water, fertilizer, or 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.

Activity Cards

Take it to the Cleaners Think about the scientist or discovery on your history card. What does it represent to you as a group? Using the pipe cleaners provided, shape them into something that represents the contribution to plant breeding during this time. Be prepared to share your creation with the other groups and explain what it means to you.	**Jingle All the Way** Think about the scientist or discovery on your history card. What does it represent to you as a group? Write a jingle or a rap that explains why the contribution or discovery was so important to plant breeding. Be prepared to perform your song with the other groups and explain what it means to you.
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.	**Creative Collage** Think about the scientist or discovery on your history card. Why was it important? Using the supplies you have, create a collage that represents the discovery or innovation on your history card. Be prepared to share your collage 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 sheet of paper 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 sheet of 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.
News to You Think about the scientist or discovery on your history card. Why was it important? As a group, write a short news story about the discovery or scientist on your history card (200 words or less). Be prepared to deliver your news story to your live audience (the rest of the groups).	

Dr. Carver Human Timeline Statements

Carver is too sick to do his regular work and turns to gardening.	Carver is kidnapped.
Carver is awarded multiple U.S. patents. What were they for?	Asked to become the director of Department of Agricultural Research at what is now Tuskegee University.
Receives Honorary membership in American Inventers Society.	Carver changes studies from piano and art to agriculture.
Earns honorable mention for painting at Chicago World Fair.	Earns the nickname "Plant Doctor". Why?
Offered school faculty position at Iowa Agricultural College, the first African-American to hold this position.	At Tuskegee, Carver develops a crop rotation method. With which crops? What is the advantage?

Key for Carver Human Timeline Activity:

1. Carver kidnapped. **1864**
2. Carver too sick to do his regular work and turns to gardening. **Circa 1870**
3. Earns name 'Plant Doctor'. **Carver produced his own plant-based medicines on-farm. Circa 1875**
4. Carver changes studies from piano and art to agriculture**. Circa 1890-92**
5. Earns honorable mention for painting at Chicago World's Fair. **1893**
6. Offered school faculty position at Iowa Agricultural College. **1894**
7. Asked to become the director of department of agricultural research at what is now Tuskegee University. **1896**
8. At Tuskegee, Carver develops a crop rotation method. With which crops? What is the advantage? **Circa early 1900s Carver suggests rotating peanuts or field peas with cotton crops in order to replenish soil nutrients. The increase in peanut production as more farmers followed his rotation necessitated Carver find alternative uses for this peanut excess!**
9. Carver is awarded multiple U.S. patents. What are they for? **Patents issued, two in 1925, one in 1927. Patents issued for Cosmetics, paints and stains derived from peanuts and naturally derived clays in soil.**