GENERATIONGENIUS
ALWAYS QUESTION. ALWAYS WONDER.

LESSON PLAN

BIOTECHNOLOGY

GRADES 6-8

SUMMARY

Students engage in an investigation to figure out one-way humans have used biotechnology to solve a problem.

NEXT GENERATION SCIENCE STANDARDS CORRELATION

MS-LS4-5. Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms.

Science & Engineering Practices	Connections to Classroom Activity
Obtaining, Evaluating, and Communicating Information	• Students engage in an investigation to analyze data about a population of corn. Students use the data to create an explanation for how human used artificial selection to solve a problem. • Students watch the Generation Genius video and use the information from the videos as evidence artificial selection and other ways human use biotechnology.

Disciplinary Core Ideas	Connections to Classroom Activity
LS4.B: Natural Selection In artificial selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. One can choose desired parental traits determined by genes, which are then passed onto offspring.	• Students are introduced to this idea during the opening video. Students explore this idea during the corn investigation. This idea is addressed and expanded upon during the Generation Genius video.

Cross Cutting Concepts	Connections to Classroom Activity
Cause and Effect	• Students use and discuss cause and effect relationships throughout the lesson. They create an explanation for how the corn, grape, and other populations change. • They discuss how biotechnology has enhanced human lives and discuss how this is demonstrated within the Generation Genius video.

DURATION

60 min

MATERIALS

- 9 green chips per group
- 12 blue chips per group
- 12 red chips per group
- 8 yellow chips per group
- 1 brown paper bag per group

ENGAGE

Show students a short video clip from Cotton Candy Grapes (0:00 to 3:12). Next, have students record any questions they have about the grapes. Then have students share their questions in small groups. Facilitate a group discussion and encourage students to share their questions with the whole class. Record all students' questions on the board or other public space. Anticipated questions include:

- Can you get grapes to taste like cotton candy?
- How did they know how to make them taste different than regular grapes?
- Why do they still look like regular green grapes?
- What do they do to the grapes to give them all the different shapes and colors?

Have students reflect on their own traits (natural hair color, eye color, height, etc.) and ask where those came from. From prior knowledge they should know they get their traits from their parents—remind students that grapes also get their traits from their parents. Have students work in small groups to brainstorm ideas of how these grape farmers made grapes that taste like cotton candy. From their ideas, ask groups to make an initial model of how they think the cotton candy grapes might have been developed.

Next, engage in a gallery walk, with one person from each group staying back to answer questions from the other groups. If students need prompting on how to ask probing questions to their peers, provide them with prompts such as:

- Could you explain…
- Tell me about why you included...
- Have you thought about…

Following the gallery walk, have students revise their initial models by incorporating any feedback they choose (it's not essential that they include every point.)

At this stage, students will not have all the information they need to explain how growers have modified the grapes. Instead, student models should be used to show background knowledge, prior understanding from earlier grades, incomplete ideas, and misconnections. It is not important to correct misconceptions, incomplete science ideas, or the difference between natural and artificial selection. As students progress through the rest of the lesson, they will discover and develop these concepts on their own.

EXPLORE

There are many different ideas about how ordinary-looking green grapes taste like cotton candy. In this part of the lesson, students will explore some plants and animals to figure out more about what is going on. The goal is for students to grow corn that is always tall and sweet.

Conducting the Investigation

This investigation allows students to collect data about how humans might manipulate a plant population, using a practice called artificial selection. Artificial selection is when humans determine what organisms to breed together to get a desired trait or traits. In our investigation, we want corn that is both sweet and tall.

Break students into pairs or small group and hand out the materials. Each group will need:

- 9 green chips
- 12 blue chips
- 12 red chips
- 8 yellow chips
- 1 brown paper bag
- the investigation sheet

To begin the investigation, record the first trial in row 1 of the data chart, a cross between 2 short /not-sweet plants (SN x SN). Since the plant DNA combines randomly, we cannot be sure what kind of corn we will get. Instructions to the students should include the following:

- Use the chart to add chips to your bag. (For this first round, put 9 green, 3 blue, 3 red and 1 yellow.)
- Pull out 6 chips from the bag and document them in your data chart.
- For row 2, pick two of the 6 chips to cross (you can only cross from the row directly above).
- Put the new 'seeds' in the bag based on your parent plant choice.
- Pull out 6 chips and document.
- Keep going until time is up or until you can make the desired crop of all tall and sweet plants.

When the investigation ends, engage students in a whole class discussion to share what they determined (which should include the following):

- Certain combinations of parents gave you better chances at getting the plant you wanted. For example, the first combination (SN x SN) only gave us a 1 in 16 chance of getting the plant we wanted. Other parent plant combinations gave us 8 of 16 chances to get the plant we wanted.
- Some groups never got 2 of the desired plants
- Some groups got 2 of the desired plants in a few tries.

EXPLAIN

In this section of the lesson, ask students how this investigation relates to how crops develop, and have students share their ideas. Ask students to think about how long it takes plants like corn to grow, and how long it might take for the type of corn we want to develop naturally.

Remind students that we also use this process on animals—this same process is used to create new dog breeds, some of which did not exist even 20 years ago. Have students share their ideas on how else artificial selection can be used.

When students are done sharing, define biotechnology (using biological processes to solve a problem) for the students. Explain how the corn investigation, the cotton-candy-flavored grapes, and different dog breeds are developed using biotechnology.

WATCH THE GENERATION GENIUS BIOTECHNOLOGY VIDEO AS A GROUP

ELABORATE

After the video, have students get into small groups and give them time to discuss what they learned. Each group they should decide on one thing that surprised them and one thing they would like to know more about to share with the whole class.

Circle back to the grapes they learned about at the beginning of the lesson and have students update their models to represent their new understanding of how cotton-candy grapes were developed.

EVALUATE

There are multiple ways to assess your students' understanding of this topic. The exit ticket is an opportunity for students to use the science ideas they built in the lesson in a new context. Alternatively, you can use the Kahoot! quiz (which provides downloadable scores at the end of the game) and/or the paper quiz. All these resources are located right below the video in the assessment section.

EXTENSION

Have students research a potential career in the field of biotechnology or have them research how biotechnology is used in a career field they are interested in. After they finish their research, have them present what they have found to the rest of the class, or do a poster walk to share their information. An additional option would be to interview someone in the field of biotechnology.

CORN INVESTIGATION STUDENT ACTIVITY SHEET

After planting your corn, you notice that not all corn is the same. You get a mix of short, tall, sweet, and not-sweet corn. You really want stalks that are tall, because they grow more corn, but you also want them to be sweet. In order to get the crop you desire from every plant, you decide to pollinate your plants by hand to see what kind of corn you get. Your goal is to produce a crop that is both tall and sweet. You document your data in a chart to keep track. In the current crop you notice that you have all short / not-sweet plants, but you also know you had tall and sweet corn in the past from these same seeds. You start your investigation with 2 short / not-sweet corn plants this year.

As you make new generations of corn, you need to keep track of both your parent plants and your new plants until you get all the plants to be both tall and sweet. Use the following key to keep track of your new plants.
SN – short not-sweet (green chips)
SS – short sweet (blue chips)
TN – tall not-sweet (red chips)
TS – tall sweet (yellow chips) this is your desired plant

Directions:

- In the Data Chart, row one represents your first trial, a cross between 2 short / not-sweet plants (SN x SN).
- As the plant DNA is combined randomly, you cannot be sure what kind of corn you will get. Use the chart below to add chips to your bag; for this first round you would put 9 green, 3 blue, 3 red and 1 yellow.
- Pull out 6 chips from the bag – and document them in your data chart.
- For row 2 pick two of the 6 chips to cross. (You can only cross from the row directly above)
- Put the new 'seeds' in the bag based on your parent plant choice.
- Pull out 6 chips and document.
- Keep going until time is up or until you can make the desired crop of all tall and sweet plants.

	Parent Crosses	Green chips	Blue chips	Red chips	Yellow chips
1.	SN x SN	9	3	3	1
2.	SN x SS	6	6	2	2
3.	SN x TN	6	2	6	2
4.	SN x TS	4	4	4	4
5.	SS x SS	0	12	0	4
6.	SS x TN	4	4	4	4
7.	SS x TS	0	8	0	8
8.	TN x TN	0	0	12	4
9.	TN x TS	0	0	8	8
10.	TS x TS	0	0	0	16

Generation and plants used	Short/not-sweet	Short / sweet	Tall/not-sweet	Tall/sweet
1. SN x SN				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

EXAMPLE –

- Start with SN x SN in the bag put 9 green, 3 blue, 3 red and 1 yellow.
- Pull out 6 and document, this group pulled 4 green, 1 blue, and 1 red.
- Use 2 of the plants from row 1 for your next cross, this group chose to cross the short sweet plant (SS) with the tall not sweet plant (TS).
- Change the chips in the bag to represent the seeds they could produce - 4 of each color chips for this parent combination, and then pull out 6 chips and document them in row 2.
- From line 2, the group chose to cross the tall not-sweet plant with the tall sweet plant (TN x TS) so next they put 8 red chips and 8 yellow chips in the bag and pulled 6 chips.

Generation and plants used	Short/not-sweet	Short / sweet	Tall/not-sweet	Tall/sweet
1. SN x SN	4	1	1	
2. SS x TN	2	0	3	1
3. TN x TS	0	0	4	2
4. TS x TS	0	0	0	6
5.				
6.				
7.				