



Lesson 2 of 8

Careers with Plants: Research and Development

Created: 06/2025 by the National FFA Organization

Description of Lesson: *This lesson introduces students to the role of research and development in plant science by exploring how companies develop new agricultural products. Students will engage in a hands-on plant breeding simulation to understand the importance of genetics and innovation in modern agriculture.*

Student Learning Objectives:

After completing these activities, students will ...

1. Explain the role of research and development in agriculture.
2. Identify key careers in plant science research and development.
3. Conduct a plant breeding simulation to understand genetic selection.

Suggested Grade Level:

Grades 9 and 10 (This lesson is written so instructors can scale up or down based on class needs.)

Suggested Time: 100 minutes (*Time requirements may vary based upon student understanding and class schedule.)

Resources/References:

1. Video: Gregor Mendel's Punnett Squares, <https://www.youtube.com/watch?v=d4izVAkhMPQ>
2. Website: AgExplorer (2023), AgExplorer.FFA.org

Related Resources:

1. AgExplorer Implementation Guide, <https://FFA.box.com/s/w3o6ep5l2509qtwlfsqrkc7l8o3d143m>
2. Jared Poldervaart – SAE Dairy Farm, <https://FFA.box.com/s/v9bcx7h4jn3eam3sqzsv3j3s7klj0fxs>
3. Who Is Syngenta? <https://FFA.box.com/s/rn1aabyi6ndcils11mptx4ewkiw340j>

Equipment and Supplies Needed:

1. A copy of the “Plant Breeding Challenge” worksheet for each student
2. [Plant Breeding Trait Cards](#) cut out ahead of time, one set per student or group
3. Dice, one per student or group

Vocabulary:

1. Allele
2. Cross Breeding
3. Dominant Allele
4. Genetics
5. Heterozygous
6. Hybrid
7. Punnett Square
8. Recessive Allele

Cross-Curricular Connections:

Science	English/Language Arts	Technology	Mathematics I
---------	-----------------------	------------	---------------

Name: _____

Investigate dominant/recessive alleles in plant genetics.	Research careers and complete a career profile.	Explore the different roles within Plant Systems.	Calculate trait inheritance probabilities.
---	---	---	--

SAE and FFA Connections

1. Agronomy CDE, [FFA.org/participate/cdes/agronomy/](https://ffa.org/participate/cdes/agronomy/)
2. Floriculture CDE, [FFA.org/participate/cdes/floriculture/](https://ffa.org/participate/cdes/floriculture/)
3. Nursery/Landscape CDE, [FFA.org/participate/cdes/nursery-landscape/](https://ffa.org/participate/cdes/nursery-landscape/)
4. SAE Idea Cards, <https://ffa.box.com/v/saeideacards>

Student Activity Sheets:

Direct access to student activity sheets without lesson plan or answer key for easy upload to a learning management system or printing for classwork.

<https://ffa.box.com/s/mbnv4rgnb5bl0b7znkwrihpmvf/hhhmm> (Word)

<https://ffa.box.com/s/e079jt3q6atab463y38zgdpkud3tz7o4> (PDF)

<https://docs.google.com/document/d/1Dk4rrZdvPuOGk2jtGCai22PG4yhKnUlrgyU5gSY1NYY/copy> (Google)

These Activities Are Aligned to the Following Standards:

FFA Precept

- FFA.PL-A.Action: Assume responsibility and take the necessary steps to achieve the desired results, no matter what the goal or task at hand.
- FFA.PL-C.Vision: Visualize the future and how to get there.
- FFA.PL-E.Awareness: Understand personal vision, mission and goals.
- FFA.PL-F.Continuous Improvement: Accept responsibility for learning and personal growth.
- FFA.PG-I.Professional Growth: Assume responsibility for attaining and improving upon the skills needed for career success.
- FFA.PG-J.Mental Growth: Embrace cognitive and intellectual development relative to reasoning, thinking and coping.
- FFA.CS-M.Communication: Effectively interact with others in personal and professional settings.
- FFA.CS-N.Decision Making: Analyze a situation and execute an appropriate course of action.

AFNR Cluster Skills

- CS.05. Describe career opportunities and means to achieve those opportunities in each of the Agriculture, Food & Natural Resources career pathways.

Common Core – Speaking and Listening

- CCSS.ELA-Literacy.SL.9-10.1 Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9-10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
- CCSS.ELA-Literacy.SL.9-10.2 Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source.

Common Core – Science & Technical Subjects

- AG5 Describe career opportunities and means to achieve those opportunities in each of the Agriculture, Food & Natural Resources Career Pathways.

AFNR Career Ready Practices

- CRP.04. Communicate clearly, effectively, and with reason. Career-ready individuals communicate thoughts, ideas and action plans with clarity, whether using written, verbal and/or visual methods.
- CRP.07. Employ valid and reliable research strategies. Career-ready individuals are discerning in accepting and using new information to make decisions, change practices or inform strategies.
- CRP.08. Utilize critical thinking to make sense of problems and persevere in solving them. Career-ready individuals readily recognize problems in the workplace, understand the nature of the problem, and devise effective plans to solve the problem.
- CRP.10. Plan education and career path aligned to personal goals. Career-ready individuals take personal ownership of their own educational and career goals, and they regularly act on a plan to attain these goals.

Partnership for 21st Century Skills

- Communication
- Critical Thinking and Problem Solving
- Initiative and Self-direction
- Leadership and Responsibility

Name: _____

Lesson Plan:

1. **Bell Ringer:** What qualities make a crop successful? List three key traits that you think are important.
2. **Introduction:** *Agriculture plays a crucial role in feeding the world's population, and plant science companies like Syngenta are at the forefront of developing new products to improve food production. Through research and development, scientists create crops that can withstand pests, disease and environmental challenges. In this lesson, we will explore the science behind plant breeding and genetic selection. You will take on the role of a plant scientist, selecting key traits to develop an improved crop variety. By the end of this activity, you will better understand how research and development drive innovation in modern agriculture.*
Start the lesson by showing the video about Punnett Squares,
<https://www.youtube.com/watch?v=d4izVAkhMPQ>.
An additional lesson to introduce Punnett Squares can be found here:
<https://FFA.box.com/s/v9bcx7h4jn3eam3sqzsv3j3s7klj0fxs>.
3. **Activity:** Each student needs a copy of the worksheet "Plant Breeding Challenge."
 - a. **Part 1:** Students work in small groups (two to four students) or individually. Each group/individual will need one set of the [plant breeding trait cards](#).
 1. Each group chooses three traits and records why they chose them.
 2. Assign heterozygous genotypes (e.g., Dd) to both parents for each trait.
 3. Students draw a 2x2 Punnett Square for each trait.
 4. They calculate the percentage of offspring expected to express the trait.
 5. Instruct students to answer the reflection questions.
 - b. **Part 2:** Each group or individual student will need one die. Now that students have used Punnett Squares to make predictions, it's time to simulate what might happen if they cross their plant traits in the real world. They will roll dice to represent the genes passed from each parent plant, then figure out if their new plant has the traits they want.
 1. For each of the three traits students have selected, they will roll FOUR dice — two for each parent plant.
 2. Have students use the chart included on their student activity sheet to figure out whether each parent passed on the dominant or recessive version of the trait.
 3. They will write the result (allele) from each parent. Then, have students cross them to make the offspring's genotype (like Dd or dd).
 4. They will complete a Punnett Square for each cross.
 5. Have students record all of this on their Hybrid Creation Table.
 6. When done, students will answer the discussion questions.
 - c. **Part 3:** Students will work individually or in their groups to create a three- to five-minute presentation. Instruct them to use the prompts and rubric to complete their presentations. *Optional: Allow peers to vote or give compliments after each presentation. (One thing I learned was ...)
 - d. **Part 4:** Students will select one career of interest from the list of plant science research and development careers. They will use AgExplorer (AgExplorer.FFA.org/focus/plant-systems/) to complete the profile.
4. **Follow-up:** Discuss the impact of plant breeding and biotechnology on modern agriculture. How do researchers ensure that new plant varieties meet the needs of farmers and consumers?
5. **Optional – Extended Learning Opportunities (Not factored into time requirement):**
 - a. Have students research a real Syngenta hybrid seed product and compare it to their own hybrid plant design.
6. **Exit Ticket:** What is one career in research and development that interests you? Why?

Name: _____

Plant Breeding Challenge

Part 1

Directions:

In this activity, you'll choose traits for your ideal crop and use Punnett Squares to predict how likely those traits are to appear.

Step 1: Choose Your Traits.

Pick three traits from the trait cards. Think about why each trait would be important for a successful plant.

Trait 1: _____

Why is this trait important? _____

Trait 2: _____

Why is this trait important? _____

Trait 3: _____

Why is this trait important? _____

Step 2: Assign Alleles for Each Trait.

Choose two-letter allele combinations (e.g., Dd = Drought Tolerant). Assume each parent is heterozygous.

Trait 1: _____

Parent A: _____ Parent B: _____

Trait 2: _____

Parent A: _____ Parent B: _____

Trait 3: _____

Parent A: _____ Parent B: _____

Step 3: Use Punnett Squares.

Fill in the Punnett Square below for each trait. Use capital letters for dominant traits and lowercase for recessive.

Trait 1 Punnett Square: _____

What percentage of the offspring will show the desired trait? _____%

Name: _____

Trait 2 Punnett Square: _____

What percentage of the offspring will show the desired trait? _____%

Trait 3 Punnett Square: _____

What percentage of the offspring will show the desired trait? _____%

Step 4: Reflection

1. Did your plant pass on all the traits you hoped for? Why or why not?
2. What would you change about your breeding plan if you could try again?

Name: _____

Part 2

Directions:

Now that you've used Punnett Squares to make predictions, it's time to simulate what might happen if you actually cross your plant traits in the real world. You'll roll dice to represent the genes passed from each parent plant, then figure out if your new plant has the traits you want.

1. For each of the three traits you selected, you will roll FOUR dice — two for each parent plant.
2. Use the chart below to figure out whether each parent passed on the dominant or recessive version of the trait.
3. Write the result (allele) from each parent. Cross them to make the offspring's genotype (like Dd or dd).
4. Complete a Punnett Square for each cross.
5. Record all of this on your Hybrid Creation Table.

Dice Roll to Allele Chart

This chart tells you which type of gene (allele) the parent passes down based on your roll:

Dice Roll	Allele Passed
1 – 3	Recessive allele (example: d)
4 – 6	Dominant allele (example: D)

Trait 1 Punnett Square:

Trait Name: _____

Roll the dice to determine the allele passed by each parent:

Parent A Roll: _____ Allele: ____

Parent B Roll: _____ Allele: ____

Now use the alleles to complete a Punnett Square:

Parent A Genotype: _____ Parent B Genotype: _____

What percentage of the offspring will show the desired trait? _____%

Name: _____

Trait 2 Punnett Square:

Trait Name: _____

Roll the dice to determine the allele passed by each parent:

Parent A Roll: _____ Allele: ____

Parent B Roll: _____ Allele: ____

Now use the alleles to complete a Punnett Square:

Parent A Genotype: _____ Parent B Genotype: _____

What percentage of the offspring will show the desired trait? _____%

Trait 3 Punnett Square

Trait Name: _____

Roll the dice to determine the allele passed by each parent:

Parent A Roll: _____ Allele: ____

Parent B Roll: _____ Allele: ____

Now use the alleles to complete a Punnett Square:

Parent A Genotype: _____ Parent B Genotype: _____

What percentage of the offspring will show the desired trait? _____%

Name: _____

Hybrid Creation Table

Fill this out for each trait you selected.

Trait Name	Parent A Die Roll	Parent B Die Roll	Offspring Genotype	Trait Shown? (✓/✗)

Reflection Questions:

1. Did your new plant get all three traits you wanted? Why or why not?
2. Which trait was the most difficult to pass on? What made it difficult?
3. If you did this again, would you pick the same parent genotypes? Why or why not?
4. If you did this 100 times, how do you think your results would change? What would stay the same?
5. Should scientists always try to create the “perfect” plant? Why or why not?

Name: _____

Part 3

Directions:

Prepare a three- to five-minute presentation. Use the questions and rubric below to guide your explanation.

1. What three traits did your group choose for your hybrid plant?
2. Why did you choose these traits? (Think about environment, nutrition, farmer use, etc.)
3. What genotypes did you assign to the parent plants for each trait?
4. Based on your dice rolls and Punnett Squares, what genotypes did your plant end up with?
5. Did your final plant have all the traits you wanted? Why or why not?
6. If you could do this again, what trait(s) or strategies would you change?

Presentation Rubric

Qualification	Very strong evidence of skill is present. (5–4 pts)	Moderate evidence of skill is present. (3–2 pts)	Weak evidence of skill is present. (1–0 pts)	Total Points (20 possible)
Presentation Skills	Is thorough and maintains eye contact	Somewhat professional and depends on the presentation	No evidence of preparation	
Grammar/Punctuation/Spelling	Spelling, grammar and punctuation are extremely high quality with two or less errors in the document.	Spelling, grammar and punctuation are adequate with three to five errors in the document.	Spelling, grammar and punctuation are less than adequate with six or more errors in the document.	
Time	Two minutes or more	Between one and two minutes	Under one minute	
Overall Impression	Presentation was professional, and presenter thoroughly explained the plan/idea.	Presentation was complete but lacked some detail.	The presentation lacked polish and information.	
			Total	

Name: _____

Part 4

Directions:

Choose one Plant Systems research and development career that interests you from the list below. Once you have identified your career, utilize the Career Profiles from AgExplorer (AgExplorer.FFA.org/focus/plant-systems/) to complete the profile below.

Careers in research and development:

- Research and Development Manager
- Plant Scientist/Field Agronomist
- Research Scientist
- Biotechnologist
- Plant Geneticist
- Plant Breeder
- Horticulturist
- Soil Scientist
- Agronomist
- Plant Pathologist

Career Name: _____

- Responsibilities



- Education/Training



- Where they work



- Job outlook



Name: _____

KEY: Plant Breeding Challenge

Part 1

Directions:

In this activity, you'll choose traits for your ideal crop and use Punnett Squares to predict how likely those traits are to appear.

Step 1: Choose Your Traits

Pick three traits from the trait cards. Think about why each trait would be important for a successful plant.

Trait 1: ____ *Answers will vary.* _____

Why is this trait important? ____ *Answers will vary.* _____

Trait 2: ____ *Answers will vary.* _____

Why is this trait important? ____ *Answers will vary.* _____

Trait 3: ____ *Answers will vary.* _____

Why is this trait important? ____ *Answers will vary.* _____

Step 2: Assign Alleles for Each Trait

Choose two-letter allele combinations (e.g., Dd = Drought Tolerant). Assume each parent is heterozygous.

Trait 1: ____ *Answers will vary.* _____

Parent A: ____ *Answers will vary.* ____ Parent B: ____ *Answers will vary.* ____

Trait 2: ____ *Answers will vary.* _____

Parent A: ____ *Answers will vary.* ____ Parent B: ____ *Answers will vary.* ____

Trait 3: ____ *Answers will vary.* _____

Parent A: ____ *Answers will vary.* ____ Parent B: ____ *Answers will vary.* ____

Step 3: Use Punnett Squares

Fill in the Punnett Square below for each trait. Use capital letters for dominant traits and lowercase for recessive.

Trait 1 Punnett Square: ____ *Answers will vary.* _____

What percentage of the offspring will show the desired trait? ____ *Answers will vary.* ____%

Name: _____

Trait 2 Punnett Square: _____ **Answers will vary.** _____

What percentage of the offspring will show the desired trait? __ **Answers will vary.** ____%

Trait 3 Punnett Square: ____ **Answers will vary.** _____

What percentage of the offspring will show the desired trait? ____ **Answers will vary.** ____%

Step 4: Reflection

1. Did your plant pass on all the traits you hoped for? Why or why not?

Answers will vary.

2. What would you change about your breeding plan if you could try again?

Answers will vary.

Name: _____

Part 2

Directions:

Now that you've used Punnett Squares to make predictions, it's time to simulate what might happen if you actually cross your plant traits in the real world. You'll roll dice to represent the genes passed from each parent plant, then figure out if your new plant has the traits you want.

1. For each of the three traits you selected, you will roll FOUR dice — two for each parent plant.
2. Use the chart below to figure out whether each parent passed on the dominant or recessive version of the trait.
3. Write the result (allele) from each parent. Cross them to make the offspring's genotype (like Dd or dd).
4. Complete a Punnett Square for each cross.
5. Record all of this on your Hybrid Creation Table

Dice Roll to Allele Chart

This chart tells you which type of gene (allele) the parent passes down based on your roll:

Dice Roll	Allele Passed
1 – 3	Recessive allele (example: d)
4 – 6	Dominant allele (example: D)

Trait 1 Punnett Square:

Trait Name: ____ **Answers will vary.** _____

Roll the dice to determine the allele passed by each parent:

Parent A Roll: ____ **Answers will vary.** ____ Allele: ____ **Answers will vary.** ____

Parent B Roll: ____ **Answers will vary.** ____ Allele: ____ **Answers will vary.** ____

Now use the alleles to complete a Punnett Square:

Parent A Genotype: ____ **Answers will vary.** ____ Parent B Genotype: ____ **Answers will vary.** ____

What percentage of the offspring will show the desired trait? ____ **Answers will vary.** ____%

Name: _____

Trait 2 Punnett Square:

Trait Name: _____ *Answers will vary.* _____

Roll the dice to determine the allele passed by each parent:

Parent A Roll: _____ *Answers will vary.* _____ Allele: _____ *Answers will vary.* _____

Parent B Roll: _____ *Answers will vary.* _____ Allele: _____ *Answers will vary.* _____

Now use the alleles to complete a Punnett Square:

Parent A Genotype: _____ *Answers will vary.* _____ Parent B Genotype: _____ *Answers will vary.* _____

What percentage of the offspring will show the desired trait? _____ *Answers will vary.* _____%

Trait 3 Punnett Square

Trait Name: _____ *Answers will vary.* _____

Roll the dice to determine the allele passed by each parent:

Parent A Roll: _____ *Answers will vary.* _____ Allele: _____ *Answers will vary.* _____

Parent B Roll: _____ *Answers will vary.* _____ Allele: _____ *Answers will vary.* _____

Now use the alleles to complete a Punnett Square:

Parent A Genotype: _____ *Answers will vary.* _____ Parent B Genotype: _____ *Answers will vary.* _____

What percentage of the offspring will show the desired trait? _____ *Answers will vary.* _____%

Name: _____

Hybrid Creation Table

Fill this out for each trait you selected.

Trait Name	Parent A Die Roll	Parent B Die Roll	Offspring Genotype	Trait Shown? (✓/✗)
Answers will vary.	Answers will vary.	Answers will vary.	Answers will vary.	Answers will vary.
Answers will vary.	Answers will vary.	Answers will vary.	Answers will vary.	Answers will vary.
Answers will vary.	Answers will vary.	Answers will vary.	Answers will vary.	Answers will vary.

Reflection Questions:

1.

Did your new plant get all three traits you wanted? Why or why not?

Answers will vary.
2.

Which trait was the most difficult to pass on? What made it difficult?

Answers will vary.
3.

If you did this again, would you pick the same parent genotypes? Why or why not?

Answers will vary.
4.

If you did this 100 times, how do you think your results would change? What would stay the same?

Answers will vary.
5.

Should scientists always try to create the “perfect” plant? Why or why not?

Answers will vary.

Name: _____

Part 3

Directions:

Prepare a three- to five-minute presentation. Use the questions and rubric below to guide your explanation.

1. What three traits did your group choose for your hybrid plant?
2. Why did you choose these traits? (Think about environment, nutrition, farmer use, etc.)
3. What genotypes did you assign to the parent plants for each trait?
4. Based on your dice rolls and Punnett Squares, what genotypes did your plant end up with?
5. Did your final plant have all the traits you wanted? Why or why not?
6. If you could do this again, what trait(s) or strategies would you change?

Presentation Rubric

Qualification	Very strong evidence of skill is present. (5–4 pts)	Moderate evidence of skill is present. (3–2 pts)	Weak evidence of skill is present. (1–0 pts)	Total Points (20 possible)
Presentation Skills	Is thorough and maintains eye contact	Somewhat professional and depends on the presentation	No evidence of preparation	
Grammar/Punctuation/Spelling	Spelling, grammar and punctuation are extremely high quality with two or less errors in the document.	Spelling, grammar and punctuation are adequate with three to five errors in the document.	Spelling, grammar and punctuation are less than adequate with six or more errors in the document.	
Time	Two minutes or more	Between one and two minutes	Under one minute	
Overall Impression	Presentation was professional, and presenter thoroughly explained the plan/idea.	Presentation was complete but lacked some detail.	The presentation lacked polish and information.	
			Total	

Name: _____

Part 4

Directions:

Choose one Plant Systems research and development career that interests you from the list below. Once you have identified your career, utilize the Career Profiles from AgExplorer (AgExplorer.FFA.org/focus/plant-systems/) to complete the profile below.

Careers in research and development:

- Research and Development Manager
- Plant Scientist/Field Agronomist
- Research Scientist
- Biotechnologist
- Plant Geneticist
- Plant Breeder
- Horticulturist
- Soil Scientist
- Agronomist
- Plant Pathologist

Career Name: ____ **Answers will vary.** _____

- Responsibilities  :

Answers will vary.

- Education/Training  :

Answers will vary.

- Where they work  :

Answers will vary.

- Job outlook  :

Answers will vary.