

The Cruciferous Question: How Traits Are Passed Down

High School Biology | Seed Standard 3.2 | Lesson time: 70 Minutes

What Students Will Figure Out

- Students will identify patterns in how traits are passed down from parents to offspring by reading about the ability to taste PTC paper.

Lesson Snapshot:

In this lesson, teachers will have students taste cruciferous vegetables and PTC paper to identify patterns in how they both taste. Then, students will read about the ability to taste and look for more patterns in how this trait is passed down from parents to offspring. Students will make Punnett squares predicting their parent genotypes based on their ability to taste the PTC paper.

Phenomenon

PTC paper and how the ability to taste is inherited.

SCIENCE AND ENGINEERING PRACTICES	DISCIPLINARY CORE IDEAS	CROSSCUTTING CONCEPTS
Analyzing and interpreting data: Students analyze various types of data in order to create valid interpretations or to assess claims/conclusions.	LS3.A: Inheritance of Traits: Many characteristics of organisms are inherited from their parents. (3-LS3-1)	Patterns: Students observe patterns to organize and classify factors that influence relationships.
This lesson could be one in a series of lessons building toward the following Performance Expectation(s): students are able to make predictions and use computational thinking to show how traits are passed from parents to offspring.		

Materials

Student Materials	Teacher Materials	Optional Teacher Resources
Cabbage or other cruciferous vegetable, cut up into small pieces Sticky notes PTC paper Student Cruciferous worksheet Learn Genetics PTC Reading North America PTC Taste Test Results PTC pedigree Worldwide Tasting Graph	Teacher Slides Learn Genetics PTC website Adjective Cards Jigsaw Activity Instructions	World Wide PTC Data Graph World Wide Table non-tasters

Student Materials –extension activity	
Hitchhiker's Thumb Pea Plant ABO Blood Type Earlobes	Widow's Peak Albinism Colorblindness Stat tables (earlobes, little fingers, thumb)



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Lesson Preparation

MATERIAL PREPARATION

Previous Knowledge: How to perform a monohybrid cross using Punnett squares.

Material Set-Up:

- Have cabbage cut up in cups or coffee filters to pass out easily.
- Make copies of worksheets and any articles to be passed out from teacher materials.
- Have PTC paper spread out on a paper plate or cafeteria tray to quickly distribute.

Vocabulary Definitions:

- **Dominant:** The gene expressed despite the presence of another allele (T)
- **Recessive:** The gene not expressed when the dominant allele is present (t)
- **Genotype:** The genetic makeup of an organism (TT, Tt, tt)
- **Phenotype:** The physical trait that an organism develops as the result of the genotype (tall, short)
- **Allele:** One member of the gene pair (T or t)

Experience the Phenomenon or Experience the Problem

What Students Are Doing

Students will taste a cruciferous vegetable and PTC paper to gather data about trait variation in class.

Teacher Guidance

1. Cruciferous Vegetable Taste Test

- Pass out sticky notes and a small piece of cruciferous vegetable for students to taste (broccoli, cabbage, Brussels sprouts, etc.).
- Students will describe how the vegetable tastes on **5 sticky notes**.

2. Gather Qualitative Data

- Place [Adjective Cards](#) around the room and have students place their sticky notes under the terms they wrote down. If any students wrote a term not in the Descriptive Terms papers, then make a new category(s).
 - Alternative: Write words on the board and collect tally marks.
- Have a class discussion about how the vegetable tasted and use the sticky notes as class qualitative data.

3. PTC Taste Test

- Pass out PTC tasting paper and have students record on their student worksheets if they can or cannot taste.
- On the board, record the class data of tasters and non-tasters for class quantitative data.
- Have students graph the class data on their worksheet.
- Debrief as a class and discuss what the paper tasted like. Have students compare the taster vs. non-taster data to their descriptive terms data to find patterns between the qualitative and quantitative data.
- After students have graphed their data, they will go around the school and gather more data from teachers and other students.
 - Alternative: If you don't want to send your students around the entire school, you can ask teachers close to you to interrupt their classes or gather the data at a faculty meeting and then show it to the students.

- f. Have students compare the class data to the school data and see if there are any patterns between the two.

Possible student questions

Students might wonder, “Why do some people taste the paper and others don’t?” “Why does it taste like paper?” “Why does it taste so bad?” “Wait, you can’t taste it!? It tastes terrible!”

Investigate the Phenomenon

What Students Are Doing

Teacher Guidance

4. Jigsaw Group Reading
 - a. Pairing the data sets with the Learn Genetics reading helps students understand the data.
 - b. Pass out copies of [Learn Genetics PTC](#) and PTC data sets to students. Have students read specific sections and then share those sections.
 - c. Data sets:
 - [North American PTC results](#)
 - [Global variations in sensitivity](#)
 - [PTC pedigree](#)
 - i. Students will summarize their reading on the worksheet (question 5)
 - ii. Students will summarize the entire article (question 6)
 - d. Have a class discussion about the reading so students understand what is happening at the genetic level to make something taste bitter. Ask students if they saw any patterns to how the trait for tasting is inherited.
 - i. Make sure students understand that the ability to taste bitterness is a dominant trait.

Additional Guidance

During the jigsaw, ask students, “What makes something taste bitter?” “Is there an advantage to something tasting bitter?” Students might not understand that the advantage is to the bitter-tasting organism, not the one eating it.

Ask, “What patterns did you find in the readings or graphs that help you understand how tasting is inherited? Listen for questions on genetic terms like dominant and recessive.

Model the Phenomenon

What Students Are Doing

Students will now work backward and determine their parents’ genotypes based on their data, then create a Punnett square to show the inheritance. Students then analyze data from different traits in organisms to find more patterns of inheritance. As an optional assessment, students can use their knowledge of how traits are inherited to create the perfect dog breed. They can draw or explain this dog’s traits and how they received them from their parents.

Teacher Guidance

5. Punnett Square Creation
 - a. Students will define Dominant and Recessive on the student worksheet.



- b. Using what they learned in the reading, students will answer questions on the student worksheet about what alleles and genotypes their parents must have based on their ability to taste.
 - c. Students will now create a Punnett square about **how their family passed down their tasting ability.**
 - d. Have students make predictions about what genotypes and phenotypes their children would have based on their ability to taste if they had children with someone who was a taster.
6. Extension: Second Jigsaw
 - a. If you feel students need to look at more traits, or in an honors class, you can have them read about more traits.
 - b. Pass out different traits to students from the resources provided (blood type, pea plants, hitchhiker's thumb). Students will read about these traits and look at pedigrees and other graphics to identify patterns as to how these traits are inherited.
7. On the student worksheet (question 12), students will summarize their reading and write down what patterns they noticed. They will identify the traits as dominant or recessive based on the patterns.
8. Students will share the traits they read with other groups to see multiple patterns of inheritance.
9. Optional Assessment Piece:
 - a. Students will now use their knowledge of how traits are inherited to create the perfect dog breed. They can draw or explain this dog's traits and how they received them from their parents.
 - b. [Patterns of Inheritance Worksheet](#)

Optional Extension Activity

Create a dog breed

Patterns of Inheritance Assessment

- Be sure students create dog breeds for a specific purpose (i.e., herding, companion, guard dog, hunting dog, etc.).
- Ensure breeds being crossed are compatible; no Great Dane/toy poodle crosses.
- Listen for any confusion on dog breeds or dog purposes.

[Link to Lesson folder](#)

This lesson was created by Jens Andreason, Linsey Hanseon, Donna Ward, & Thomas Wilder



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