Corn as an Introduction to Mendelian Genetics

A Carolina Essentials™ Activity

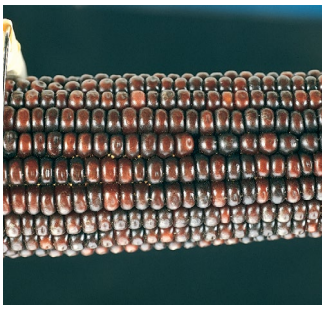
Overview

Corn is the ideal organism for introducing students to Mendelian genetics. Corn kernels express numerous phenotypes that are easy to recognize. The phenotypes typically used involve the color or shape of the kernel.

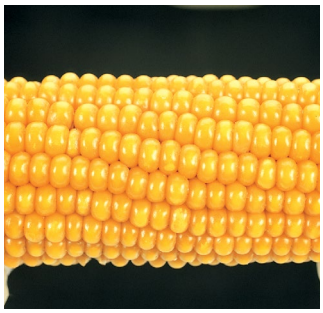
Carolina maintains parental stocks of yellow and purple corn colors. Purple corn is the result of a dominant allele, and yellow corn is the result of the recessive allele of the same gene. Each kernel on an ear of genetic corn represents an offspring. This means students can immediately begin collecting data without performing genetic crosses themselves. Since there are generally 200 or more kernels per ear, it takes only a few ears to produce reliable data.

Students will gather data on 2 monohybrid crosses: purple crossed with yellow, and the resulting F_1 crossed with F_1 corn. The F_1 of the purple: yellow cross expresses the purple phenotype and looks like the purple parent stock, but it carries the recessive allele for yellow. When the F_1 kernels are planted and allowed to freely cross-pollinate, the recessive phenotype reappears in the resulting F_2 ears in a 3:1 ratio. The phenotype breakdown for the purple: yellow cross consists of 3 purple (dominant) and 1 yellow (recessive).

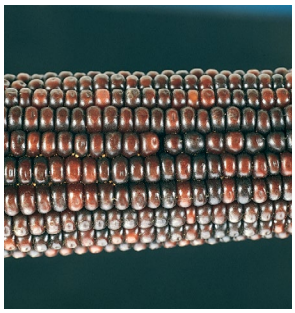
Life Science
Grades: 9–12



Purple Starchy Parent (RR)



Yellow Starchy Parent (rr)



Purple Starchy F_1 (Rr)

Phenomenon

Hold up the parental ears of corn (purple and yellow). Ask students this question: What do you need to ask about these ears of corn to know what kind of offspring they could produce? Give students 2 to 3 minutes to generate questions individually and then share with the class. Guide students to questions that can be answered using genetics.

Essential Question

Based on Mendelian genetics, what questions need to be asked and then answered to predict the phenotypic traits of offspring?

Activity Objectives

1. Ask, then answer the questions necessary to determine the genetic relationships between parent, F_1, and F_2 generations of corn.
2. Test the answers to the questions above using Punnett squares.

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TIME REQUIREMENTS

PREP	ACTIVITY
15 min	30-45 min

Teacher Prep: 15 min
Student Activity: 30-45 min

MATERIALS (PER GROUP)

1 purple starchy parent for demonstration

1 yellow starchy parent for demonstration

1 F_2 ear of corn per group

Calculator (optional)

Note: Carolina's genetic corn is pollinated, grown, and harvested under controlled conditions. The use of other varieties of corn may or may not yield the correct phenotypic ratios.

HELPFUL LINKS

Corny Genetics

Carolina LabSheets™: Seedling Genetics (Corn)

Carolina's Genetic Corn: Part 1—Pollination

Carolina's Genetic Corn: Part 2—Harvesting

Carolina's Genetic Corn: Part 3—Preparing the Seeds

Carolina's Genetic Corn: Part 4—Preparing for Shipment

Bring Your Genetics Lessons to Life with Model Organisms

Corn Genetics: Hip Hop Genes

Epigenetics I: Using Carolina Corn Ears to Teach Genetic Imprinting

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Next Generation Science Standards* (NGSS)

PE HS-LS3-1. Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems • Ask questions that arise from examining models or a theory to clarify relationships.	**LS3.A: Inheritance of Traits** • Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways.	**Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

REFERENCE KITS

Monohybrid Genetics with Corn Kit

Mendelian Genetics of Corn Kit

Safety Procedures and Precautions

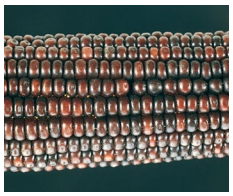
Corn ears have been treated with a sealant, but make certain to identify students with corn allergies to determine whether handling the corn will cause an allergic reaction.

Teacher Preparation and Disposal

Examine each F_2 ear of corn to ensure that kernels are not missing. If an ear has a large number of missing kernels, then the ratio of phenotypes could be incorrect. Collect corn ears and store them in a cool dry place for extended use.

Student Procedure

1. Observe the first generation, F_1, of offspring from the cross of a purple kernel parent and a yellow kernel parent. Record the observations in the data table.
2. Observe the F_2 generation of corn. Count the number of each different phenotype (color) of kernel.
3. Add the data to the class data table.
4. Record the class data.



F_1 Generation

Teacher Preparation and Tips

Review the terms recessive, dominant, homozygous, and heterozygous.

Create a class data table for all groups to enter their data. You may wish to complete the calculations as a class if students have difficulties with math.

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Data and Observations

Corn Kernels Phenotype

	Phenotype (color)	Phenotype (color)
F_1	All purple	
F_2	purple	yellow

Count of F_2 Corn Kernels

F_2	Phenotype (color)	Phenotype (color)
Group	180 purple	60 yellow
Class Totals	1442 purple	478 yellow
Class Percent	(1442/1920) × 100 = 75%	(478/1920) × 100 = 25%

Ratio of Purple to Yellow	75/25 = 3:1 or 1442/478 = 3:1

Analysis and Discussion

1. Based on your data for the F_2 generation, which phenotype appears to be dominant? What evidence supports that claim?

   Purple is dominant because there are three times more purple kernels.

2. Based on your data for the F_2 generation, which phenotype appears to be recessive? What evidence supports that claim?

   Yellow is recessive because it does not show up in the parental cross (F_1 generation), and there are 3 times fewer yellow kernels in the F_2 generation.

3. Which of Mendel's laws is being investigated? Support your answer.

   The law of dominance is the primary law because we are comparing the ratio of the purple phenotype to the yellow phenotype. The law of segregation is also used when identifying the specific trait of kernel color.

4. Examine the questions you asked after observing the parent generation of corn ears. Place a check mark by the questions you could answer using the information from the data table. For the questions you didn't answer, write down notes about what it would take to get an answer. *Students answers will vary. Look for the check marks in the phenomenon section.*

5. Use **R** for purple and **r** for yellow. List the genotype for the parent and F_1 generations. *Parents: Purple-RR, Yellow-rr F_1:Rr*

6. Using a Punnett square, perform a cross between a homozygous purple parent and yellow parent.

	R	R
r	Rr	Rr
r	Rr	Rr

7. Using a Punnett square, perform a cross between 2 F_1 offspring. Include the phenotype in each block of the Punnett square.

	R	r
R	RR purple	Rr purple
r	Rr purple	rr yellow

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8. Calculate the ratio of phenotypes of the F_2 generation. *3 purple to 1 yellow*

9. How do the calculated class phenotype ratio and the F_2 generation ratio from the Punnett square compare? Apply Mendel's laws to explain the differences or similarities.

   The ratios are the same. Mendel's law of dominance gave a ratio of 3:1 using the Punnett square, and the ears of corn gave the same ratio indicating purple is the dominant allele and yellow is the recessive allele.

10. Examine any questions you couldn't answer using the data on the genetic crosses. Place a check mark by any additional questions you could answer. For the questions you still did not answer, highlight or underline the ones that genetics may answer.

    Student answers will vary. Students should be able to determine if a question is out of the realm of being answered with genetics.

TEACHER NOTES