

# Punnett squares

<b>Focus question</b>	How do breeders predict which traits will be in offspring? How might biotechnology methods improve the process?
<b>Vocabulary</b>	Genotype, phenotype, alleles, homozygous, heterozygous, dominant, recessive, Law of Independent Assortment, F1, F2

Use Punnett squares to show results from a hybrid cross and determine the genotypic ratios and phenotypic ratios of a hybrid. If a plant breeder is interested in creating a better corn plant, one with some traits from one variety and some traits from another, the traditional method is to cross these two varieties and look for the plants that exhibit the combination of traits desired.

## Procedure

### Monohybrid Cross: A cross looking at one gene for a trait

- Cross Colored Aleurone with the **genotype** (RR) corn with Colorless Aleurone, genotype (rr), in the Punnett square below to show the **F1** results. Circle the correct words below:  
The RR genotype is *homozygous* / *heterozygous* and *dominant* / *recessive*.

	R	R	
r			• What are the resulting genotypes? What is the percent?
r			

**RR × rr**

• What are the resulting **phenotypes**? What is the percent?

- When you cross two of the offspring from above, what will be the result in the **F2** generation? Circle the correct word in the sentence below:  
The Rr genotype is *homozygous* / *heterozygous*.

	R	r	
R			• What are the resulting genotypes? What are the percents?
r			

**Rr × Rr**

• What are the resulting phenotypes? What are the percents?

- Count the kernels on the cob to determine the actual ratio.

## Dihybrid cross: Looking at two genes that are on two different chromosomes

Use the model *Carolina Biological Supply 17-6900 Dihybrid cross* to complete the activity below.

4. Cross Colored Aleurone (RR), Starchy (SU/SU) corn with Colorless Aleurone (rr), Sweet Endosperm (su/su), in the Punnett square below to show the F1 results.

	<b>r su</b>	<b>r su</b>	<b>r su</b>	<b>r su</b>
<b>R Su</b>				
<b>R Su</b>				
<b>R Su</b>				
<b>R Su</b>				

**R R SU / SU × r r su / su**

- What are the resulting genotypes?
- What are the resulting phenotypes?

5. When you cross two of the offspring from above, what will be the result in the F2 generation?

	<b>R SU</b>	<b>R su</b>	<b>r SU</b>	<b>r su</b>
<b>R SU</b>				
<b>R su</b>				
<b>r SU</b>				
<b>r su</b>				

**R R SU / SU × r r su / su**

- What are the resulting genotypes?
- What are the resulting phenotypes?

6. How might you get 100% colorless and sweet offspring?

## Reflection

1. How long would it take for a farmer to accomplish this amount of crossing on his/her own?
2. What are some traits that farmers may value that could be a result of two different corn varieties?
3. Seed chipping is a technique originally discovered by Monsanto. Watch this video DEKALB® Breeding HQ: Seed Chipping Technology [youtu.be/gCb9TSpuxUU](https://youtu.be/gCb9TSpuxUU). How much time does this technique take off of the typical hybridization cycle?
4. Look for other techniques being used to cut the time it takes to make new hybrids (i.e. TALEN, gene silencing, CRISPR). Describe how these methods are helping reduce the time to create new lines that will have increased resistance to weed pressure, pests, and drought.

## Rubric for self-assessment

Skill	Yes	No	Unsure
I correctly completed a Punnett square for a monohybrid cross.			
I correctly completed a Punnett square for a dihybrid cross.			
I understand Mendel's Law of Independent Assortment and its impact on the traits in these crosses.			
I discovered at least one new technique in breeding that has impacted the development of new hybrids.			