Student's Name _____ Class _____ Date _____

**LAB-AIDS® #603S INVESTIGATING AND APPLYING GENETICS**
**(CORN CROP GENETICS)**
**Student Worksheet and Guide - Part I**

**Breeding Corn Plants**

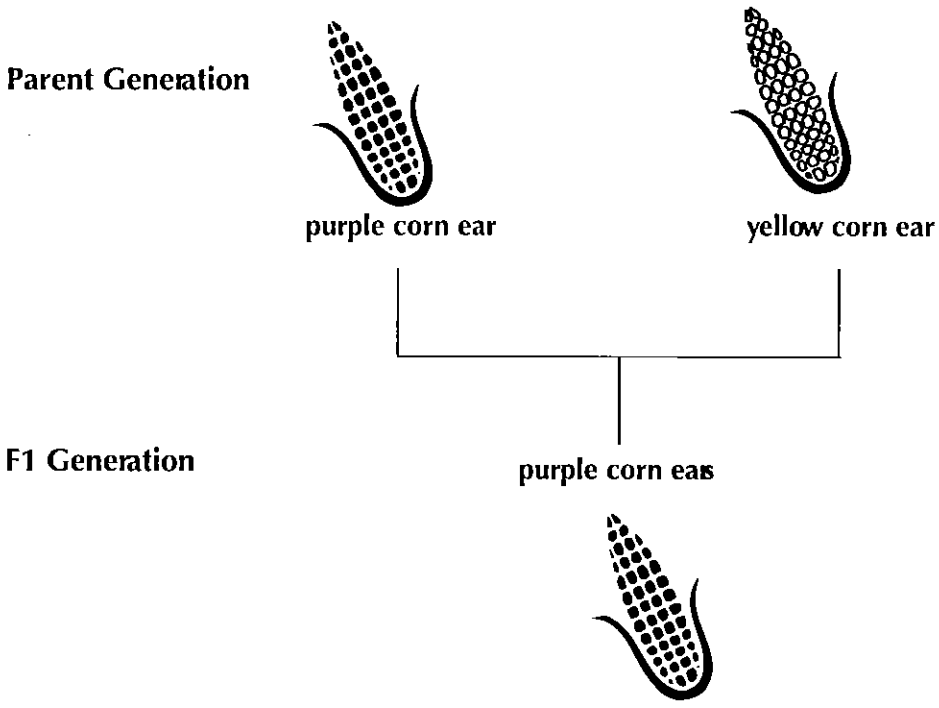
The corn you eat is the end product of hundreds of years of selective breeding of corn plants to produce large ears with sweet kernels. In **selective breeding**, one corn plant with a desirable trait such as good taste would be bred with another plant with a desirable trait such as large kernels. The offspring with better taste and larger kernels would be selected for further breeding. Through many generations of selective breeding, the taste and size of corn kernels have been greatly improved. Even today, plant breeders constantly try to improve the taste, disease resistance, yield, and shelf life of crops such as corn.

Each kernel on an ear of corn is an individual embryo produced by breeding parent corn plants. This means that each kernel is a potential offspring. The color of a corn kernel is determined by a single **gene**. Each kernel receives one **allele**, or version, of this color gene from each parent. You will use uppercase and lowercase letters to represent different alleles of the same gene. The two alleles are described by the plant's **genotype**. A kernel with two of the same allele has a **homozygous** genotype (such as SS or ss). A kernel with two different alleles for a gene has a **heterozygous genotype** (such as Ss). You will investigate ears of corn produced by breeding yellow-eared corn plants with purple-eared corn plants.

Figure 1 shows the corn ears that result from a cross between a corn plant homozygous for purple kernels and a corn plant homozygous for yellow kernels. The resulting ears have only purple kernels! They must have a heterozygous genotype, but the trait they display, called their **phenotype**, is purple.

These offspring are called the F1 generation.

**Figure 1: Breeding yellow-eared corn plants with purple-eared corn plants**



**Challenge**

What colors of corn kernels will result from the following crosses:

- heterozygous purple X homozygous purple plants?
- heterozygous purple X homozygous yellow plants?
- heterozygous purple X heterozygous purple plants?

**Materials**

*For each group of four students*

1 each of Corn Ears A and B

**Procedure**

1. Count the number of purple kernels and the number of yellow kernels on each of your two corn ears. Record your results in the data table below.

| | Number of purple kernels | Number of yellow kernels | Ratio of purple: yellow kernels | Ratio rounded to nearest whole number |
|---|---|---|---|---|
| Corn Ear A | | | | |
| Corn Ear B | | | | |

2. Calculate the ratio of purple to yellow kernels by dividing the number of purple kernels by the number of yellow. Use your results to complete the data table above.

**Questions**

1. When a corn plant with all purple kernels is crossed with a corn plant with all yellow kernels, the offspring have all purple kernels, as shown in Figure 1. How would you explain this observation?

   _____

   _____

   _____

2. If a corn plant that produces ears with only yellow kernels has the genotype pp and a corn plant that produces ears with only purple kernels has the genotype PP,

   a. What is the genotype of the offspring corn plant that carries one allele for yellow and one allele for purple color? _____

   b. What type(s) of sex cells (or gametes) can this plant produce? _____ and _____

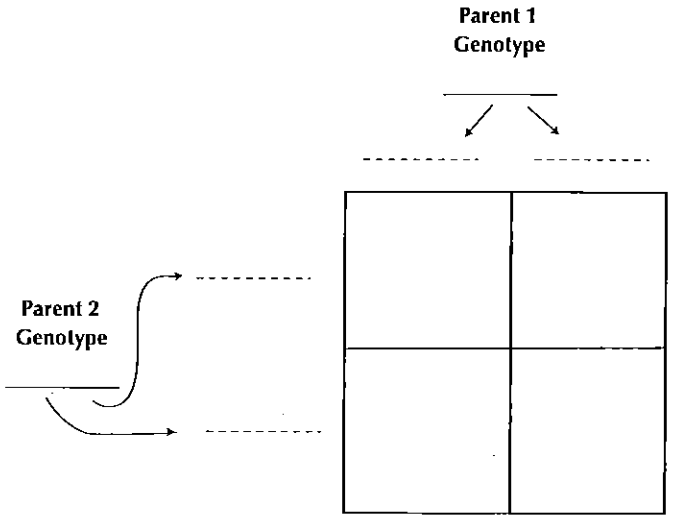
3. What do you predict will happen if a heterozygous (Pp) corn plant is bred with a homozygous plant with purple kernels? Explain your answer and provide a Punnett square.

Punnett square for Question 3

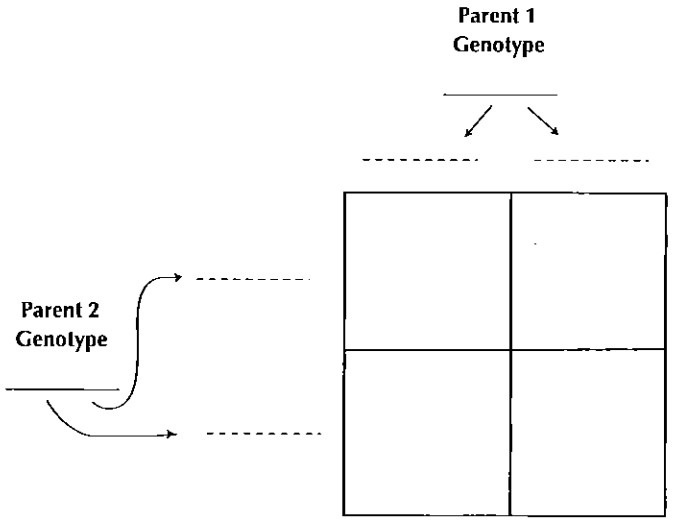
Parent genotypes: _____ X _____

Gametes: Parent 1: _____ and _____

Parent 2: _____ and _____




4. What do you predict will happen if a heterozygous (Pp) corn plant is bred with another heterozygous corn plant? Explain your answer and provide a Punnett square.



5. What do you think was:

   a. the genotype of each parent of Corn Ear A? _____ X _____

   b. the genotype of each parent of Corn Ear B? _____ X _____

6. Explain how you came up with your answers for Question 5.

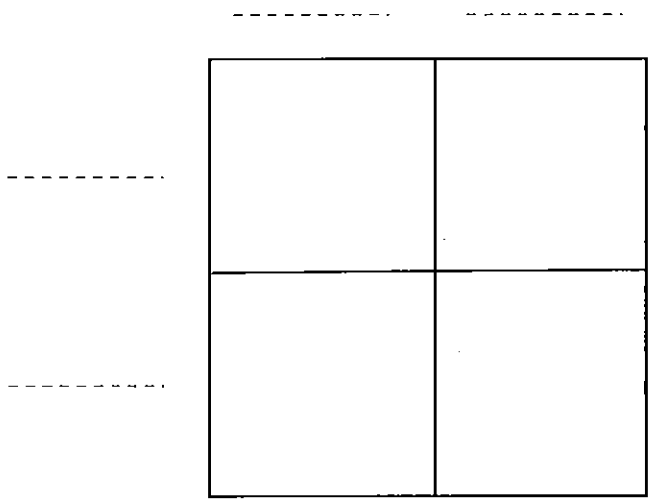
_____

_____

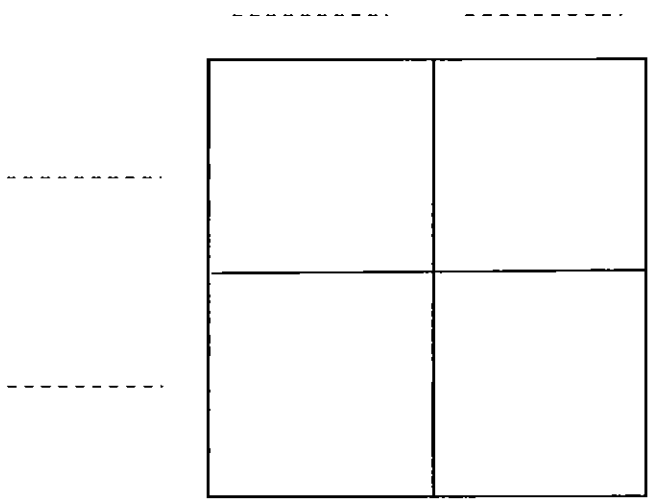
_____

7. Use Punnett squares to support your answer for Question 6.
   Hint: Work backwards! First fill in your proposed kernel genotypes in the boxes.
   Write P___ for purple kernels. Then deduce the parental genotypes.

**Punnett Square for Corn Ear A**



**Punnett Square for Corn Ear B**



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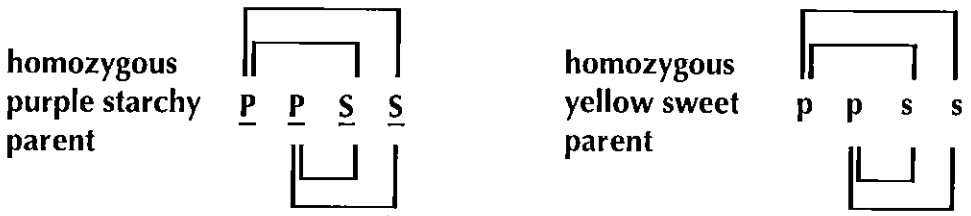
**Student Worksheet and Guide - Part II**

**Breeding Corn for Two Traits**

Now you will examine the inheritance of two traits determined by genes found on different chromosomes in corn: the color of the corn kernels (purple vs. yellow) and the taste of the kernels (sweet vs. starchy). Sweet kernels are wrinkled in appearance; starchy kernels are smooth. Purple is dominant over yellow, and starchy is dominant over sweet. The genotype of a homozygous purple and starchy corn plant can be written PPSS; the genotype of a homozygous yellow and sweet variety can be written ppss.

What type of corn will we get if we cross a homozygous purple and starchy plant (PPSS) with a homozygous yellow and sweet one (ppss)? Each plant produces gametes with one allele for each trait. The homozygous purple and starchy plant (PPSS) can only produce gametes with a purple allele for the color trait and a starchy allele for taste (PS). The homozygous yellow and sweet plant (ppss) produces only yellow sweet gametes (ps). The possible allele combinations that each parent can donate are shown in Figure 1. As you can see, each parent can form four possible allele combinations, but in this case the resulting four possibilities are identical. You don't need a Punnett square to predict that all offspring will have a PpSs genotype.

**Figure 1: Possible alleles donated by each parent**




**Challenge**

What kinds of corn kernels will result from a cross between two first-generation PpSs plants?

**Materials**

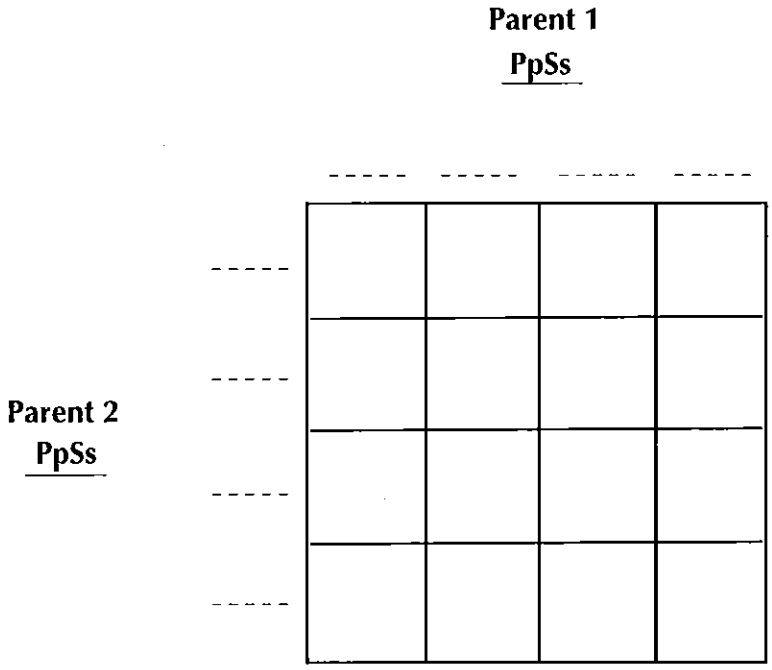
1 each of Corn Ears C and D

**Procedure**

1. Begin by determining the possible alleles in the gametes from each parent. What combinations of alleles can be produced by each PpSs parent? (Remember, each combination should include one of the alleles for color and one of the alleles for starchy or sweet.)

2. Fill the possible allele combinations in the dotted blanks on the Punnett square on the next page.

3. Complete the Punnett square showing the genetic possibilities for the offspring of a cross between two PpSs parents.




4. Corn Ear C is the result of a cross between two first-generation PpSs plants. It is called the second generation or F2. Count the number of each of the four kernel types found on Corn Ear C. Record your results in the data table below.

| | # purple starchy (smooth) kernels | # purple sweet (wrinkled) kernels | # yellow starchy (smooth) kernels | # yellow sweet (wrinkled) kernels |
|---|---|---|---|---|
| Corn Ear C | | | | |
| Corn Ear D | | | | |

**Questions**

1. According to your Punnett square, how many different genotypes should be present in the kernels of second-generation Corn Ear C? List them.

_____

_____

_____

2. According to your Punnett square, how many different phenotypes should be observed in the kernels of Corn Ear C? List them.

3. Use your Punnett square to predict the ratio of the different phenotypes produced by this cross. Express your ratio in this form:

   _#_ purple starchy: _#_ purple sweet: _#_ yellow starchy: _#_ yellow sweet

   _____ purple starchy: _____ purple sweet: _____ yellow starchy: _____ yellow sweet

4. How closely did the ratio of phenotypes from Corn Ear C in your data table correspond to the ratio predicted by the Punnett square?

5. Would you expect the actual ratio to be the same as the predicted ratio? Why or why not?

6. Imagine you have several corn plants that have produced only purple starchy kernels. You want to determine whether these plants are homozygous for the dominant purple and starchy traits. What could you do to find out if your plants are homozygous?

7. Imagine that you carried out the procedure you proposed for Question 6 and your results are plants with ears like Corn Ear D.

   a. Count the kernels on Corn Ear D and record your results in the data table.

   b. Is your plant homozygous or heterozygous for the two traits? Explain your answer.

_____

_____

_____

   c. Create a Punnett square for the cross that produced Corn Ear D. (Hint: Work backwards. Fill in what you know in the Punnett square and use this information to figure out what is missing. )