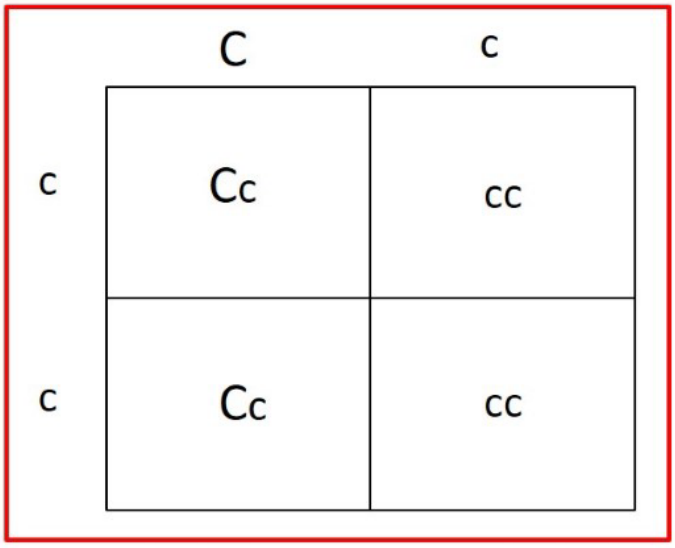
# Exercise 1: Monohybrid Cross

**Table 1: Millet Seed Genotypes and Phenotypes**

| | Genotype | Phenotype |
|---|---|---|
| Homozygous Dominant | CC | Smooth coat |
| Heterozygous | Cc | Smooth coat |
| Homozygous recessive | Cc | Wrinkled coat |

**Photo 1: Cross Producing Seeds in Kit (Cc x cc)**




**Data Table 2 : Expected Ratios**

| | |
|---|---|
| Phenotypic Ratio | 1:1 |
| Genotypic Ratio | 1:1 |
| Offspring expected to be smooth (%) | 50 |
| Offspring expected to be wrinkled (%) | 50 |

**Table 3: Millet Seed Data**

| | Round Seeds | Wrinkled Seeds | Total |
|---|---|---|---|
| Observed number of individuals | 604 | 378 | 982 |
| Expected number of individuals | 491 | 491 | 982 |

**Panel 1: Chi-square Calculation for Millet Seeds**

*Student answers should use values from Data Table 3.*

$$x^2 = \frac{(604-491)^2}{491} + \frac{(378-491)^2}{491} = 52$$

**Table 4: Millet Seed Chi-square Test**

| | |
|---|---|
| **Degrees of Freedom** | 1 |
| **p-Value range** | <0.005 |
| **Conclusion** | Difference between expected and observed is statistically significant |

**Question 1**

Explain the difference between the terms genotype and phenotype.

*Genotype refers to the genetic makeup of an organism, whereas phenotype refers to the observable characteristics of an organism. The genotype determines the phenotype of an individual.*

**Question 2**

The seeds in this exercise were produced by a heterozygous parent and homozygous recessive parent as described in step 4. List all possible crosses that could have produced the homozygous recessive parent (cc).

*The homozygous recessive parent could have been produced by the following crosses: cc x cc, Cc x cc, and Cc x Cc.*

**Question 3**

Was the Punnett square created in this exercise a good predictor of offspring phenotypes resulting from a cross between a homozygous recessive wrinkled-seed-producing millet plant and a heterozygous smooth-seed-producing millet plant? Reference Photo 1 and the results recorded in Data Table 4 in your explanation.

*Note to instructors: seeds are packaged by mass and not by percentages. For this reason, student results and answers will vary. All answers should be supported by* ***Data Table 4****.*

*No, the Punnett square in Photo 1 predicted that 50% of the offspring would be smooth and 50% of the offspring would be wrinkled. However, significantly more smooth seeds were present in the sample (604) than were wrinkled seeds (398). The difference was statistically significant producing a p-value <.005 as recorded in Data Table 4.*

# Exercise 2: Dihybrid Crosses

**Data Table 5 : Description of Corn Offspring**

| | |
|---|---|
| Phenotypic Ratio | 9:3:3:1 |
| Genotypic Ratio | 4:2:2:2:2:1:1:1:1 |
| Offspring expected to be purple-smooth (%) | 56.25% |
| Offspring expected to be purple-wrinkled (%) | 18.75% |
| Offspring expected to be yellow-smooth (%) | 18.75% |
| Offspring expected to be yellow-wrinkled (%) | 6.25% |

**Table 6: Kernel Phenotypes and Genotypes**

| Phenotype | Possible Genotype(s) | # of Possible Genotypes |
|---|---|---|
| Purple-smooth | PPSS, PPSs, PpSS, PpSs | 4 |
| Yellow-smooth | ppSS, pp,Ss | 2 |
| Purple-wrinkled | PPss, Ppss | 2 |
| Yellow-wrinkled | ppss | 1 |

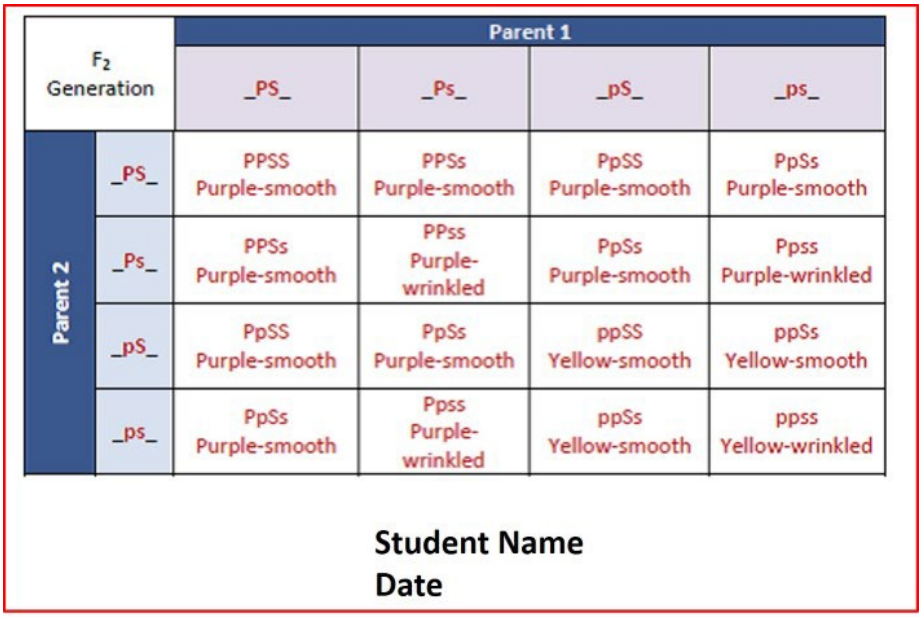
**Table 7: Genotypes of True-Breeding Corn**

| True-Breeding Phenotype | Genotype | # of Possible Genotypes |
|---|---|---|
| Corn that produces only purple-smooth kernels | PPSS | 1 |
| Corn that produces only yellow-smooth kernels | ppSS | 1 |
| Corn that produces only purple-wrinkled kernels | PPss | 1 |
| Corn that produces only yellow-wrinkled kernels | ppss | 1 |

**Table 8: Allelic Combinations for Axes**

| Genotype | Genotype |
|---|---|
| Parent: PpSs | Combination 1: PS |
| | Combination 2: Ps |
| | Combination 3: pS |
| | Combination 4: ps |

**Photo 2: Cross of Heterozygous Corn (PpSs x PpSs)**



| $F_2$ Generation | | Parent 1 _PS_ | Parent 1 _Ps_ | Parent 1 _pS_ | Parent 1 _ps_ |
|---|---|---|---|---|---|
| Parent 2 | _PS_ | PPSS Purple-smooth | PPSs Purple-smooth | PpSS Purple-smooth | PpSs Purple-smooth |
| | _Ps_ | PPSs Purple-smooth | PPss Purple-wrinkled | PpSs Purple-smooth | Ppss Purple-wrinkled |
| | _pS_ | PpSS Purple-smooth | PpSs Purple-smooth | ppSS Yellow-smooth | ppSs Yellow-smooth |
| | _ps_ | PpSs Purple-smooth | Ppss Purple-wrinkled | ppSs Yellow-smooth | ppss Yellow-wrinkled |

**Student Name**
**Date**

**Table 3: Dialysis Membrane and Glucose**

| Substance | Glucose (Y/N) |
|---|---|
| Solution outside of dialysis tubing (cup 1) | Y |
| Solution in dialysis tubing (cup 2) | Y |
| Distilled water | N |

**Data Table 9: Description of Corn Offspring**

| | |
|---|---|
| Phenotypic Ratio | 9:3:3:1 |
| Genotypic Ratio | 4:2:2:2:2:1:1:1:1 |
| Offspring expected to be purple-smooth (%) | 56.25% |
| Offspring expected to be purple-wrinkled (%) | 18.75% |
| Offspring expected to be yellow-smooth (%) | 18.75% |
| Offspring expected to be yellow-wrinkled (%) | 6.25% |

**Data Table 10: Description of Corn Offspring**

| | Purple-smooth | Purple-wrinkled | Yellow-smooth | Yellow-wrinkled | Total # of offspring |
|---|---|---|---|---|---|
| Expected # of Individuals | 278 | 92 | 92 | 31 | 493 |

| | Purple-smooth | Purple-wrinkled | Yellow-smooth | Yellow-wrinkled | Total # of offspring |
|---|---|---|---|---|---|
| Section A (observed) | 53 | 27 | 17 | 3 | 100 |
| Section B (observed) | 93 | 21 | 25 | 12 | 151 |
| Section C (observed) | 89 | 17 | 32 | 8 | 146 |
| Section D (observed) | 62 | 21 | 11 | 2 | 96 |
| Observed Number of Offspring (A + B + C + D) | 297 | 86 | 85 | 24 | 493 |

**Panel 2: Chi square Calculation for Corn Offspring**

$$x^2 = \frac{(297-278)^2}{278} + \frac{(86-92)^2}{92} + \frac{(85-92)^2}{92} + \frac{(25-31)^2}{31} = 3.38$$

**Table 11: Corn Chi-square Test**

| | |
|---|---|
| **Degrees of Freedom** | 3 |
| **p-Value range** | 0.500-0.050 |
| **Conclusion** | p = 0.500 – 0.050 therefore p > 0.05. There is not a statistically significant difference between the expected and observed values. |

**Question 1**

Was the Punnett square created in this exercise a good predictor of offspring phenotypes resulting from a dihybrid cross of heterozygous parents? Reference Photo 2 and Data Table 11 in your explanation.

*Yes, the Punnett square in Photo 2 predicted a phenotypic ratio of 50%, 19%, 19%, and 6% for purple-smooth, purple-wrinkled, yellow-smooth, and yellow-wrinkled, respectively. The numbers of each phenotype in the sample were 297, 86, 85, and 25. The difference between the expected numbers and observed numbers of the phenotypes was not statistically significant producing a p-value range 0.500-0.050 as recorded in Data Table 11.*

**Question 2**

Would a cross between a homozygous purple-smooth parent (PPSS) and a parent that is heterozygous for both traits (PpSs) result in offspring that produced either yellow or wrinkled seeds? Explain your answer by listing the genotypes and phenotypes produced by the cross.

*No, all offspring would produce purple, smooth seeds. The genotypes of the offspring would be: PPSS, PpSS, PPSs, and PpSs. An offspring would need to be homozygous recessive for either of the traits to produce yellow or wrinkled seeds.*

**Extension Question**

A plant collector locates a wild population of lilies composed of 75% spotted flowers and 25% solid colored flowers. The collector selects seeds from several of the spotted individuals and plants the seeds in their garden. The collector is surprised that 25% of the resulting lilies produced solid colored flowers. Apply your knowledge of Mendelian genetics to explain why the collector did not produce only spotted flowering plants in their garden.

*The sampled population exhibited a 3:1 phenotypic ratio of spotted flower plants to solid colored flower plants suggesting that the genotypic ratio of the population was 1:2:1 for the flower color allele, with the solid color being recessive. By selecting seeds from only a few plants, the collector was likely selecting seeds from the heterozygous plants. When planted in the collector's garden, these seeds would result in plants with a 3:1 phenotypic ratio of spotted flowers to solid flowers.*