# Assignment Summary

For this assignment, you will create and analyze Mendelian and non-Mendelian crosses using Punnett squares and pedigrees. You will also use chi-square hypothesis testing to draw conclusions on inheritance patterns.

Background Information

Mendel used his experimental data to determine how alleles are passed on through gametes of offspring. The law of segregation states that gametes receive only one of two alleles from parents. The law of independent assortment states that alleles on different chromosomes will separate into gametes independently of one another. These two laws can be used to predict the probability that certain alleles will be passed on from parent to offspring. They can also be used to predict the genotype and phenotype of offspring. Mendel studied traits that followed complete dominance inheritance patterns. These traits have alleles that are dominant and recessive.

Not all traits follow this inheritance pattern. There are traits that have incomplete dominance, where two alleles produce proteins that show a blended phenotype. Codominance is where two different alleles express phenotypes at the same time. Sex-linked traits are carried on the X or Y chromosome. Some genes are linked on autosomes. These genes are located close together on the same chromosome; therefore, these alleles tend to be inherited together.

A chi-squared statistical test can be used to detect whether a trait is inherited through Mendelian inheritance. You can use this equation:



***χ*2** – value of chi-square

**Σ** –sign of sum, means the total amount of elements in a sequence

**O** – observed number of a trait

**E** – expected number of a traits

Materials

* Paper
* Writing and drawing utensils
* Calculator

# Assignment Instructions

For this project, you are expected to submit:

1. A completed version of this guide, featuring calculations and answers to analysis questions.

**Step 1: Prepare for the project.**

1. Read through the guide before you begin so you know the expectations for this project.
2. If anything is not clear to you, be sure to ask your teacher.
3. Pay close attending to the formula given in the background information.

**Step 2: Analyze patterns of inheritance.**

1. Use the scenarios below to predict the offspring of the cross.
	1. Read each scenario carefully, looking for clues to the pattern of inheritance of the traits presented in the model.
	2. Complete a Punnett square and statistical analysis, if necessary, for each question.
	3. Answer the analysis questions that follow the scenarios.

**Step 3: Evaluate your project using this checklist.**

If you can check each box below, you are ready to submit your project.

* Do your Punnett squares represent the scenarios correctly?
* Did you fill out the Punnett squares with the correct genotypes and phenotypes?
* Are your Punnett squares complete and properly labeled?
* Did you conduct the chi-squared statistical tests accurately?
* Did you complete the **Written Analysis** section?

**Step 4: Revise and submit your project.**

1. If you were unable to check off all of the requirements on the checklist, go back and make sure that your project is complete. Save your project before submitting it.
2. Turn in this handout to your teacher.
3. Congratulations! You have completed your project

Scenarios and Calculations

**Scenario 1**

Albinism is a phenotype characterized by those who do not produce the pigment melanin. This affects an individual’s skin, hair, and eye color. An individual with this disorder is homozygous recessive. Complete and use the Punnett square to predict the probability of two individuals who are carriers for the trait having a child with albinism.

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**Scenario 2**

Corn has a dominant allele that prevents kernel color and a recessive allele that allows kernel color. Another allele controls for kernel color; a dominant allele gives kernels a purple color and a recessive allele gives a red color. Two plants that are heterozygous for both traits are crossed and their offspring phenotypes are recorded below. Complete the chart to determine whether to accept or reject the null hypothesis of a typical Mendelian dihybrid cross. Hint: Homozygous dominant or heterozygous for the allele for the color-depositing trait will result in neither purple nor red kernels.

|  |  |  |  |
| --- | --- | --- | --- |
| **Phenotype** | **Expected** | **Observed** | **(Observed –Expected)2 /Expected** |
| **neither purple nor red** | 750 | 719 |  |
| **purple** | 187 | 200 |  |
| **red** | 63 | 81 |  |

*X*2 = \_\_\_\_\_\_\_\_

**Chi-Square Table**

|  |  |
| --- | --- |
| ***P-*Value** | **Degrees of Freedom** |
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** |
| **0.05** | 3.84 | 5.99 | 7.82 | 9.49 | 11.07 | 12.59 | 14.07 | 15.51 |
| **0.01** | 6.64 | 9.21 | 11.34 | 13.28 | 15.09 | 16.81 | 18.48 | 20.09 |

**Scenario 3**

Fruit flies make good study organisms for heredity because they reproduce fairly quickly and have a variety of traits that are easy to track. Two traits that are studied in fruit flies are body color and wing length. Fruit flies can have two different body colors: gray or black. Wings are either normal or vestigial (quite small and nonfunctional). Gray body color is dominant to black body color, and normal wings are dominant to vestigial wings. Suppose a fly that is heterozygous for both traits was crossed with a black-bodied fruit fly with vestigial wings. Use a Punnett square to determine the expected phenotypes and genotypes.

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| --- | --- | --- | --- |
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The above experiment is repeated many times, and the phenotypes of the offspring are collected. The results are below. Use them to complete a chi-square analysis to see if the traits follow Mendelian inheritance patterns for dihybrid traits. Assume that a 1:1:1:1 phenotypic ratio is expected with independent assortment in this case.

|  |  |  |  |
| --- | --- | --- | --- |
| **Phenotype** | **Expected** | **Observed** | **(Observed –Expected)2/Expected** |
| **gray, normal wings** |  | 960 |  |
| **gray, vestigial wings** |  | 190 |  |
| **black, normal wings** |  | 211 |  |
| **black, vestigial wings** |  | 939 |  |

*X*2 = \_\_\_\_\_\_\_

**Chi-Square Table**

|  |  |
| --- | --- |
| ***P-*Value** | **Degrees of Freedom** |
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** |
| **0.05** | 3.84 | 5.99 | 7.82 | 9.49 | 11.07 | 12.59 | 14.07 | 15.51 |
| **0.01** | 6.64 | 9.21 | 11.34 | 13.28 | 15.09 | 16.81 | 18.48 | 20.09 |

Written Analysis

Answer the questions below.

1. Predict the genotypic and phenotypic ratios for the Punnett square from scenario 1. What is the probability of two individuals who are carriers for the trait having a child with albinism? What is the inheritance pattern for albinism?

For scenario 2, accept or reject the null hypothesis that the traits follow a Mendelian inheritance pattern. Do this by comparing the calculated chi-square value to the critical chi-square value. Explain your reasoning.

1. For scenario 3, accept or reject the null hypothesis that the traits follow Mendelian inheritance patterns for fruit fly wing type and body color. Explain your reasoning.
2. Using scenario 1 and one other scenario, differentiate between the inheritance patterns of the two organisms for the traits provided in the scenario.