Lab 9: Genetics & Inheritance

BIOL-8

Name: ______________________ **Date:** ______________________

Name: [ ] **Date:** [ ]

Objectives

By the end of this lab, you will be able to:

- **Apply the laws of probability** to genetic inheritance using coin tosses
- **Perform monohybrid crosses** to predict genotype and phenotype ratios
- **Demonstrate independent assortment** using dihybrid crosses (simulation)
- **Analyze human pedigrees** to determine inheritance patterns (dominant vs. recessive, autosomal vs. sex-linked)
- **Solve genetics problems** involving sex-linked traits and multiple alleles (blood types)

Introduction

Genetics is the scientific study of heredity—how traits are passed from parents to offspring. The fundamental unit of heredity is the **gene**, a segment of DNA that codes for a specific protein or trait. Genes come in different versions called **alleles**.

Key Terminology

Term	Definition
Genotype	The genetic makeup of an organism (e.g., *AA*, *Aa*, *aa*)
Phenotype	The physical expression of the trait (e.g., *Purple flowers*, *White flowers*)
Homozygous	Having two identical alleles for a trait (*AA* or *aa*)
Heterozygous	Having two different alleles for a trait (*Aa*)
Dominant	An allele that masks the presence of a recessive allele (represented by capital letters)
Recessive	

Term	Definition
	An allele that is only expressed when two copies are present (represented by lowercase letters)

In this lab, you will simulate genetic crosses, analyze real human traits, and practice predicting outcomes using **Punnett squares**.

Materials

- Two coins (pennies or nickels) per pair of students
- Calculator
- Colored pencils (optional)

Safety Considerations

- None. This is a simulation and paper-based lab.

Part 1: Probability and Genetics

> ***Learning Goal:*** *Understand how random chance determines which alleles are passed to offspring.*

Sexual reproduction involves chance. During meiosis, homologous chromosomes separate (segregate), so a parent passes only *one* of their two alleles to their offspring. Which one they pass is random—like flipping a coin.

Procedure: The Coin Toss

Imagine a parent is **heterozygous (Aa)** for a trait.

- **Heads** = Dominant allele (**A**)
- **Tails** = Recessive allele (**a**)
- **Get two coins.** One represents the **Father (Aa)**, the other represents the **Mother (Aa)**.
- **Flip both coins simultaneously** 50 times.

- Record the combination for each toss in the tally table below.
- **Heads/Heads** = **AA** (Homozygous Dominant)
- **Heads/Tails** = **Aa** (Heterozygous)
- **Tails/Tails** = **aa** (Homozygous Recessive)

Data Collection

Genotype Tally Sheet (50 Tosses)

#	Genotype	Tally (mark each toss)	Total Count	Percentage (Count ÷ 50 × 100)
1				
2				
3				
4				

Analysis

1. Theoretically, in a cross between two heterozygotes (Aa × Aa), the expected ratio is 25% AA, 50% Aa, and 25% aa. How close were your results to these percentages?

2. Why might your actual results differ slightly from the theoretical expectation?

Part 2: Monohybrid Crosses

> ***Learning Goal:*** *Use Punnett squares to predict offspring for a single trait.*

Scenario: Albinism in Humans

Albinism (lack of skin pigment) is an **autosomal recessive** condition.

- **A** = Normal pigmentation (Dominant)
- **a** = Albinism (Recessive)

Problem 1: A man who is **homozygous dominant (AA)** has children with a woman who is **albino (aa)**.

1. Draw the Punnett square:

```
      __a__    __a__
    |        |        |
A   |   ?    |   ?    |
    |________|________|
    |        |        |
A   |   ?    |   ?    |
    |________|________|
```

What is the genotype of all offspring?

What is the phenotype of all offspring?

Problem 2: Now, suppose one of the children from the cross above (who is **heterozygous Aa**) marries another person who is also **heterozygous (Aa)**.

Draw the Punnett square for Aa × Aa.

What are the expected genotypic percentages?

- AA: ____________ %
- Aa: ____________ %
- aa: ____________ %

What is the probability (as a fraction) that they will have an albino child?

____

Part 3: Dihybrid Crosses (Independent Assortment)

> ***Learning Goal:*** *Track two traits at once to see how they sort independently.*

Mendel's **Law of Independent Assortment** states that different gene pairs segregate independently during gamete formation (as long as they are on different chromosomes).

Scenario: Peas

We will look at two traits in pea plants:

1. **Seed Shape**: Round (**R**) is dominant to Wrinkled (**r**)
2. **Seed Color**: Yellow (**Y**) is dominant to Green (**y**)

Cross: Two parents are heterozygous for *both* traits: **RrYy** × **RrYy**.

Procedure

1. Determine the possible gametes each parent can produce using the **FOIL** method (First, Outer, Inner, Last).
2. Parent alleles: **R r Y y**
3. Gametes: **RY**, **Ry**, **rY**, **ry**
4. Complete the 16-square Punnett square below.

Dihybrid Cross: RrYy × RrYy

#	RY	Ry	rY	ry
1				
2				
3				
4				
5				

Analysis

Count the phenotypes in your table to find the famous **9:3:3:1 ratio**.

How many are Round & Yellow (R_Y_)?
____ / 16

How many are Round & Green (R_yy)?
____ / 16

How many are Wrinkled & Yellow (rrY_)?
____ / 16

How many are Wrinkled & Green (rryy)?
____ / 16

Part 4: Human Genetic Traits

> ***Learning Goal:*** *Observe dominant and recessive traits in yourself and classmates.*

Many human traits are complex and polygenic, but some behave (mostly) like simple Mendelian traits.

1. **Tongue Rolling**: Dominant (**T** = can roll); Recessive (**t** = cannot)
2. **Attached Earlobes**: Dominant (**E** = unattached/free); Recessive (**e** = attached)
3. **Widow's Peak**: Dominant (**W** = peak); Recessive (**w** = straight hairline)
4. **Hitchhiker's Thumb**: Dominant (**H** = straight); Recessive (**h** = bends back 90°)

Data Collection

Determine your own phenotype and possible genotype. (If you have the dominant phenotype, you could be homozygous dominant OR heterozygous, so write **T_**).

My Genetic Profile

#	Trait	My Phenotype	My Possible Genotype(s)
1			
2			
3			
4			
5			

Part 5: Pedigree Analysis

> ***Learning Goal:*** *Interpret family trees to determine inheritance patterns.*

A **pedigree** is a chart that tracks a trait through a family.

- **Square** = Male
- **Circle** = Female

- **Shaded** = Affected (has the trait)
- **Unshaded** = Unaffected

Scenario: Cystic Fibrosis (Autosomal Recessive)

Look at the following description of a family.

1. **Grandparents**: Grandpa (unaffected) and Grandma (unaffected) have a son named Bob (affected with Cystic Fibrosis).
2. **Parents**: Bob marries Sue (unaffected, no family history). They have two kids.
3. **Grandchildren**: Both kids are unaffected.

1. Draw this pedigree on a piece of paper.

2. What must be the genotype of Grandpa and Grandma? (Use F/f)

3. Why are Grandpa and Grandma called "carriers"?

4. What is Bob's genotype?

5. Assuming Sue is homozygous dominant (FF), what is the genotype of their children?

Part 6: Sex-Linked Traits

> ***Learning Goal:*** *Understand traits linked to the X chromosome.*

Genes on the X chromosome show a unique inheritance pattern. Males (**XY**) have only one X, so they express *whatever* allele is on it, even if recessive. Females (**XX**) can be carriers.

Scenario: Color Blindness (X-linked Recessive)

- **X^B** = Normal vision
- **X^b** = Color blind

Problem: A **carrier female (X^BX^b)** has children with a **normal male (X^BY)**.

1. Set up the square:

	X^B	X^b
X^B		
Y		

1. What is the probability of having a color-blind DAUGHTER?

2. What is the probability of having a color-blind SON?

3. Why represents the genotype of a carrier female?

4. Why are men much more likely to be color blind than women?

Conclusion

1. Explain the Law of Segregation in your own words.

2. If an individual has a dominant phenotype, how could you use a "test cross" to determine if they are homozygous dominant (AA) or heterozygous (Aa)?

3. How does independent assortment contribute to genetic variation?

Lab created for BIOL-8: Human Biology