# Lab 9: Genetics & Inheritance

*BIOL-8*

**Name:** _____ **Date:** _____

---

## Objectives

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

- Define key genetics terms: gene, allele, genotype, phenotype, dominant, recessive
- Use Punnett squares to predict offspring genotypes and phenotypes
- Analyze a family pedigree to trace inheritance of a trait

---

## Part 1: Key Concepts

Read each term and definition carefully. You will use these throughout the entire lab.

| Term | Definition |
|---|---|
| **Gene** | A segment of DNA that codes for a specific trait |
| **Allele** | A version of a gene (e.g., brown-eye allele vs. blue-eye allele) |
| **Diploid** | Having **two copies** of each chromosome — one from each parent — so you carry **two alleles** for every gene |
| **Genotype** | The alleles an organism carries, written with letters (e.g., *Aa*) |
| **Phenotype** | The physical trait you can observe (e.g., "brown eyes") |
| **Homozygous** | Two identical alleles (*AA* or *aa*) |
| **Heterozygous** | Two different alleles (*Aa*) — also called a **carrier** if the trait is recessive |
| **Dominant** | The allele expressed when at least one copy is present (capital letter, e.g., **A**) |
| **Recessive** | The allele expressed only when two copies are present (lowercase letter, e.g., **a**) |
| **Punnett Square** | A grid used to predict the offspring of a genetic cross |

### Check Your Understanding

**1. When we write a genotype like *Aa* or *Bb*, the capital letter and the lowercase letter each represent a different allele of the same gene. Humans are diploid, meaning they carry two copies of each gene. In your own words, explain what the genotype *Aa* tells you — what does the capital *A* represent, what does the lowercase *a* represent, and why are there exactly two letters?**

**2. If someone has the genotype *Bb*, are they homozygous or heterozygous?**

**3. An organism with genotype *aa* shows the recessive trait. What genotype(s) would show the dominant trait?**

**4. What is the difference between a genotype and a phenotype?**

**5. Why is a person with genotype *Aa* called a "carrier" for a recessive condition?**

---

## Part 2: Coin Toss — Modeling Allele Segregation

***Learning Goal:*** *See how random chance determines which allele a parent passes on.*

When a parent with genotype **Aa** makes sperm or egg cells, each cell randomly gets either the **A** or the **a**. This is like flipping a coin.

## Procedure

1. Get **two coins**. One = Father (Aa). One = Mother (Aa).
2. Flip both coins **20 times**. Record each result below.
3. **Heads** = Dominant allele (**A**)
4. **Tails** = Recessive allele (**a**)
5. Both Heads = **AA** · One of each = **Aa** · Both Tails = **aa**

## Data

## Genotype Tally (20 Tosses)

| # | Genotype | Tally | Count | Percentage (Count ÷ 20 × 100) |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |

## Questions

**1. The expected ratio for Aa × Aa is 25% AA, 50% Aa, 25% aa. How close were your results?**

**2. Would your results be closer to the expected ratio if you flipped 100 times? Why?**

## Part 3: Punnett Squares — Albinism

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

**Albinism** is a recessive condition where the body produces little or no melanin pigment.

- **A** = Normal pigmentation (dominant)
- **a** = Albinism (recessive)

### Cross 1: AA × aa

A man with normal pigmentation (**AA**) has children with a woman who has albinism (**aa**).

**Draw the Punnett square in the box below:**

**Genotype of all offspring:**

**Phenotype of all offspring:**

**Can any child from this cross have albinism? Why or why not?**

### Cross 2: Aa × Aa

Two people who are both **carriers** (Aa) have children together.

**Draw the Punnett square in the box below:**

**Expected genotypic ratio:**

- AA: _____%
- Aa: _____%
- aa: _____%

**What fraction of their children could have albinism?**

_____

**What fraction would be carriers (Aa) but look normal?**

_____

---

## Part 4: Sex-Linked Inheritance — Color Blindness

***Learning Goal:*** *Understand how traits on the X chromosome are inherited differently in males and females.*

**Color blindness** (red-green type) is a **recessive trait carried on the X chromosome**. Because males have only one X chromosome (XY), they only need one copy of the recessive allele to be color blind. Females (XX) need two copies.

- $\mathbf{X^C}$ = Normal color vision (dominant)
- $\mathbf{X^c}$ = Color blind (recessive)

| Genotype | Sex | Phenotype |
|---|---|---|
| $X^CX^C$ | Female | Normal vision |
| $X^CX^c$ | Female | Normal vision (carrier) |
| $X^cX^c$ | Female | Color blind |
| $X^CY$ | Male | Normal vision |
| $X^cY$ | Male | Color blind |

### Cross: Carrier Mother × Normal Father

A mother with normal vision who is a **carrier ($X^CX^c$)** has children with a father who has **normal vision ($X^CY$)**.

**Draw the Punnett square in the box below:**

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

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

**3. What fraction of their daughters would be carriers?**

**4. Why are males much more likely to be color blind than females? (Hint: think about how many X chromosomes each sex has.)**

## Part 5: Family Pedigree — Tracing a Trait Through Generations

> ***Learning Goal:*** *Read and draw a pedigree chart to trace how a trait is inherited in a real family.*

A **pedigree** is a diagram that shows how a trait passes through a family. Here are the standard symbols:

| Symbol | Meaning |
|---|---|
| □ | Male |
| ○ | Female |
| ■ / ● | Affected (has the trait) |
| □─○ | Mated pair |
| Vertical line down | Their children |

### Scenario: Cystic Fibrosis

Cystic fibrosis (CF) is an **autosomal recessive** condition (genotype **ff**).

- **F** = Normal (dominant)
- **f** = Cystic fibrosis (recessive)

Read the family description, then draw the pedigree in the box below.

**Generation I (Grandparents):** Frank (unaffected) and Gina (unaffected) have three children.

**Generation II (Their children):**

- **Maria** (unaffected) — marries **Tom** (unaffected). They have 2 children.
- **Carlos** — has cystic fibrosis.
- **Anna** (unaffected) — no children yet.

**Generation III (Grandchildren):**

- Maria and Tom's daughter **Lily** (unaffected)
- Maria and Tom's son **Sam** (unaffected)

### Draw the Pedigree

Use the standard symbols above. Squares for males, circles for females. Shade in anyone who is affected. Label each person with their name.

### Pedigree Analysis

**1. Carlos has cystic fibrosis (ff). He got one *f* allele from Frank and one from Gina. What must Frank and Gina's genotypes be?**

**2. Frank and Gina appear healthy but each carry one recessive allele. What is the term for this?**

**3. What are Maria's possible genotypes? (There are two options.)**

**4. If Maria is a carrier (Ff) and Tom is also a carrier (Ff), what is the probability that their child would have cystic fibrosis?**

**5. Draw the Punnett square for Ff × Ff in the box below to support your answer.**

**6. Looking at your pedigree, could you tell just by looking at appearances that Frank and Gina were carriers? Why is this important for genetic counseling?**

## Conclusion

**1. In your own words, explain why two healthy parents can have a child with a recessive genetic condition like albinism, sickle cell disease, or cystic fibrosis.**

**2. What is one thing you learned in this lab that surprised you about how traits are inherited?**

*Lab created for BIOL-8: Human Biology*