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: Punnett Squares — Sickle Cell Trait

> ***Learning Goal:*** *Apply Punnett squares to another real human genetic condition.*

Sickle cell disease is an autosomal recessive condition affecting hemoglobin in red blood cells.

- **H** = Normal hemoglobin (dominant)
- **h** = Sickle cell hemoglobin (recessive)
- **HH** = Unaffected
- **Hh** = Carrier (sickle cell *trait* — usually healthy)
- **hh** = Sickle cell *disease*

Cross: Hh × Hh

Both parents are carriers for sickle cell trait.

Draw the Punnett square in the box below:

1. What is the probability their child will have sickle cell disease (hh)?

2. What is the probability their child will be a carrier (Hh)?

3. What is the probability their child will be completely unaffected (HH)?

4. If this couple has 4 children, how many would you *expect* to be carriers? (This is a prediction, not a guarantee.)

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?