INTRODUCTION TO EVOLUTION AND GENETICS

The Foundation Contributions of Darwin, Lamarck, and Mendel

Course code: BIO 101

Session: 2025/2025

WHY THIS TOPIC?

- To understand the concepts of evolutionary theory, and its linkage to genetics
- To compare and contrast the theories of evolution by Lamarck and Darwin.
- To describe the basic principles of Mendelian inheritance.
- To define key genetic terms (gene, allele, genotype, phenotype, etc.).
- To explain how Mendelian genetics supports evolutionary theory.

CORE IDEA OF AVOLUTION

- All life on Earth shares a common ancestor and has diversified over time through processes of change.
- **Evidence for Common Ancestry**

1. **Universal Genetic Code:**
   Nearly identical DNA/RNA coding system across bacteria, plants, animals, and fungi.
2. **Conserved Molecular Machinery:**
   Same ribosomes, ATP energy currency, and core metabolic pathways in all cells.

CORE IDEA OF AVOLUTION

3. Hierarchical "Tree of Life" Patterns:

Genetic and anatomical similarities nest perfectly – like a family tree across species.

EVOLUTION AS A SCIENCE

- Evolution is the scientific study of how populations of living organisms change over time through processes of heritable variation, selection, and adaptation, resulting in both the emergence of new traits/species and the extinction of others.

EARLY SCIENTISTS CONTRIBUTIONS

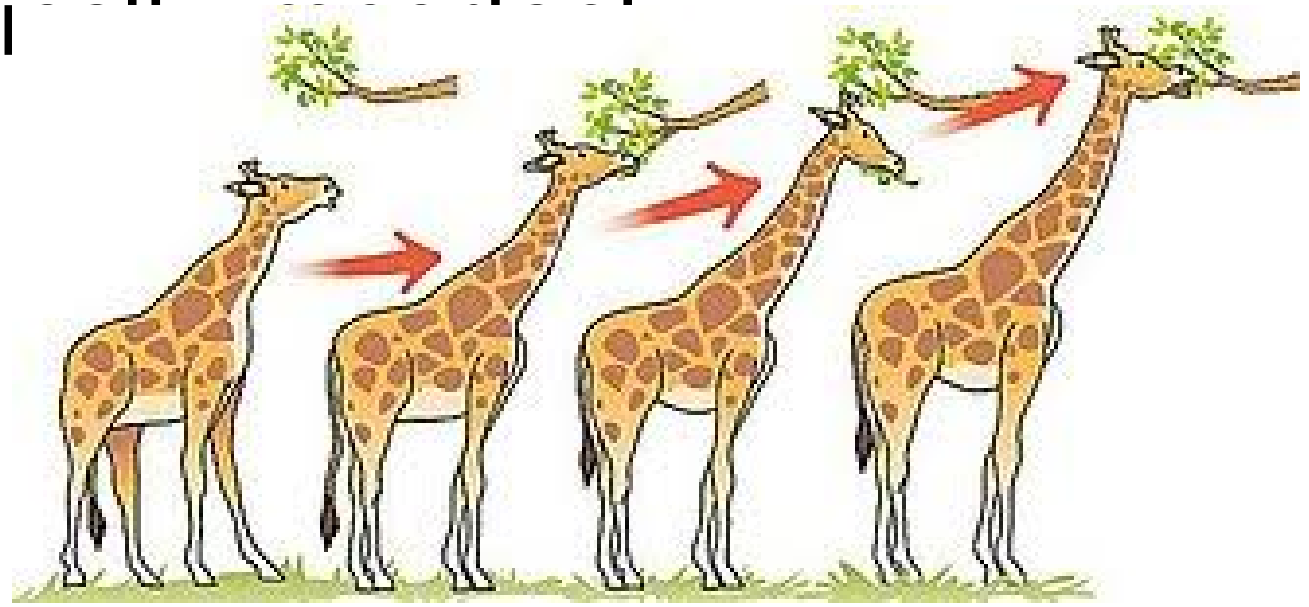
❑ Jean-Baptiste Lamarck (1744–1829)

- **Theory:** Inheritance of Acquired Characteristics
- **Two main principles:**

1. **Use and Disuse:** Organs used extensively become larger/stronger; those not used deteriorate.
2. **Inheritance:** These acquired changes are passed to offspring.

EARLY SCIENTISTS CONTRIBUTIONS

- **Lamarck Example:** Giraffes stretch necks to reach leaves → offspring inherit longer necks
- **Legacy:** One of first systematic theories of evolution; later largely disproven but histori



EARLY SCIENTISTS CONTRIBUTIONS

❑ Charles Darwin (1809–1882)

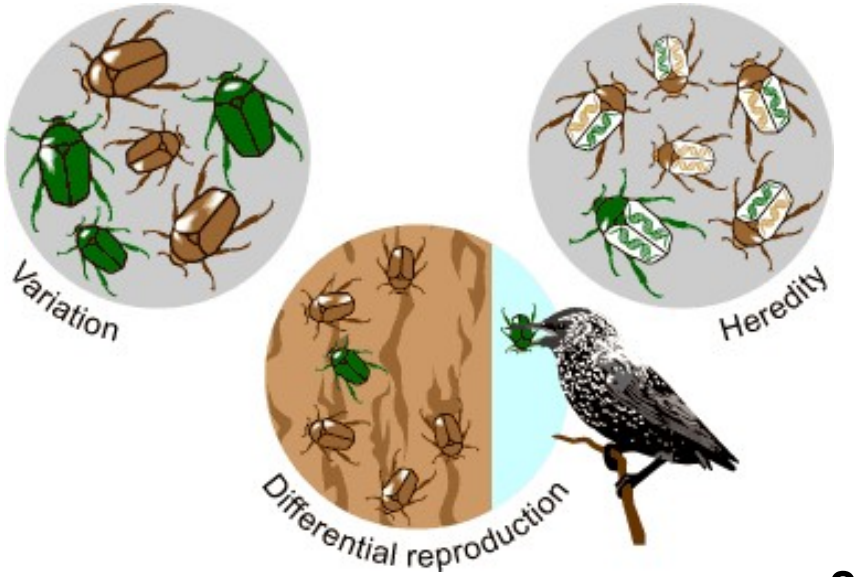
- **Theory:** Natural Selection as the primary mechanism of evolution, leading to adaptation
- **Four main principles:**
  1. **Variation:** Individuals in a population vary in traits.
  2. **Heritability:** Traits are heritable (passed from parents to offspring).
  3. **Overproduction:** Populations produce more offspring than can survive.

EARLY SCIENTISTS CONTRIBUTIONS

4. **Differential Survival/Reproduction:** Individuals with traits better suited to environment are more likely to survive and reproduce.

- **Result:** Over time, advantageous traits become more common in the population.

Different species of rabbits



EARLY SCIENTISTS CONTRIBUTIONS

❑ Comparison of Lamarckism vs. Darwinism

Aspect	Lamarck	Darwin
Direction of change	Driven by need/use	Driven by environmental fit
Mechanism	Acquired traits inherited	Natural selection acts on existing variation
Example	Giraffe neck stretches	Giraffes with longer necks survive better
Inheritance	Changes during lifetime passed on	Traits inherited via genes (unknown to Darwin)

- **Important Note: Lamarck and Darwin** provided compelling observational and theoretical explanations for evolution (how species populations change) in the 19th century.

EARLY SCIENTISTS CONTRIBUTIONS

❑ Gregor Mendel (1822–1884)

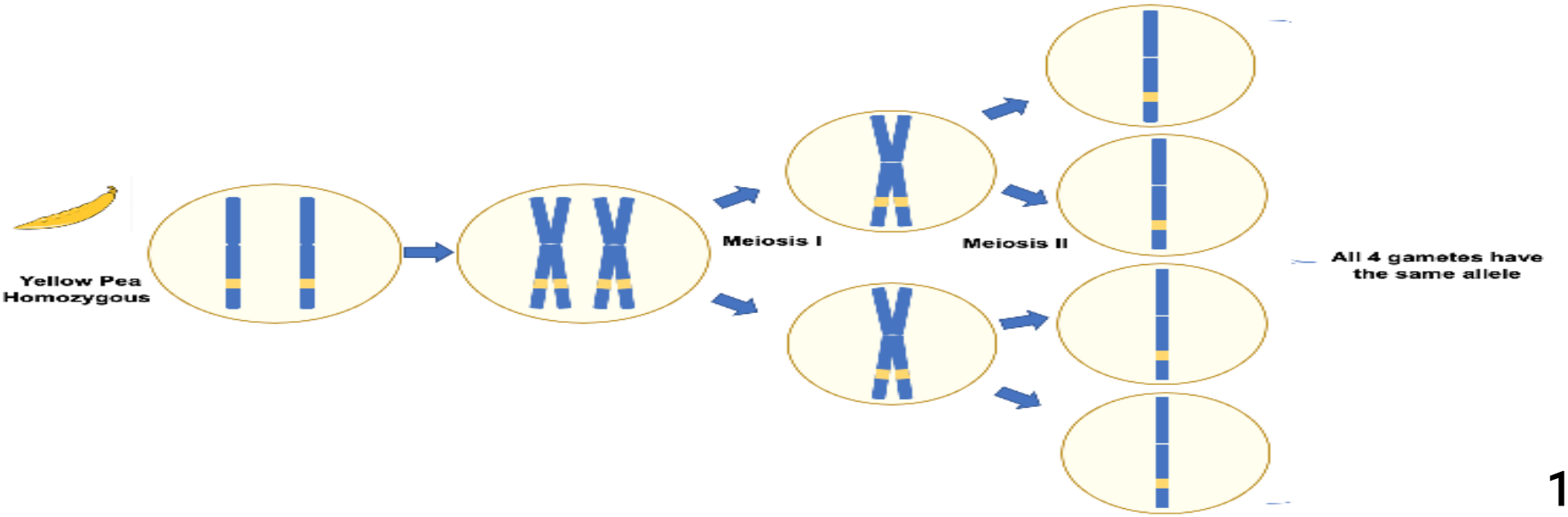
- **Theory: Laws of Inheritance,** *Provided the experimental and quantitative mechanism for heredity, later recognized as the genetic foundation for evolution.*
- **Three Key Principles (Mendel's Laws):**

1. Law of Segregation
2. Law of Independent Assortment
3. Law of Dominance

EARLY SCIENTISTS CONTRIBUTIONS

1. **Law of Segregation:**

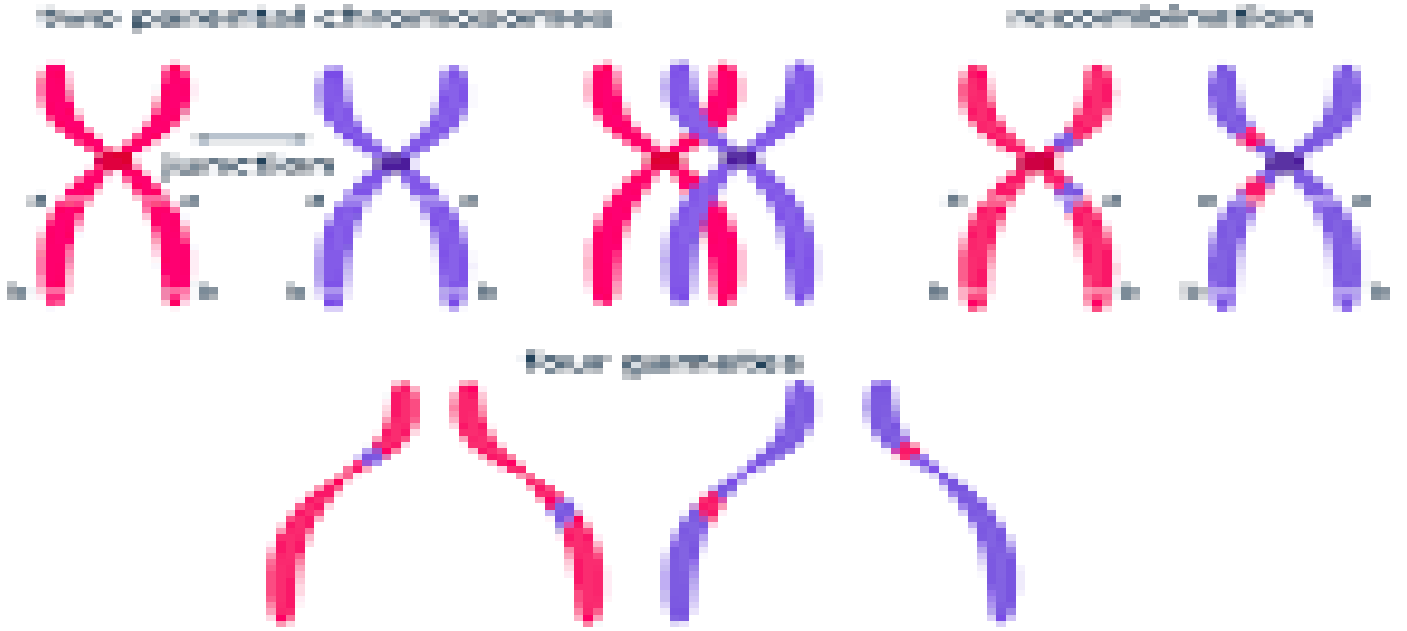
- Each individual carries two alleles for each gene.
- These alleles **separate (segregate)** during gamete formation, so each gamete carries c



EARLY SCIENTISTS CONTRIBUTIONS

2. Law of Independent Assortment:

•Genes for different traits are inherited **independently** of one another (*applies to genes on different chromosomes*)

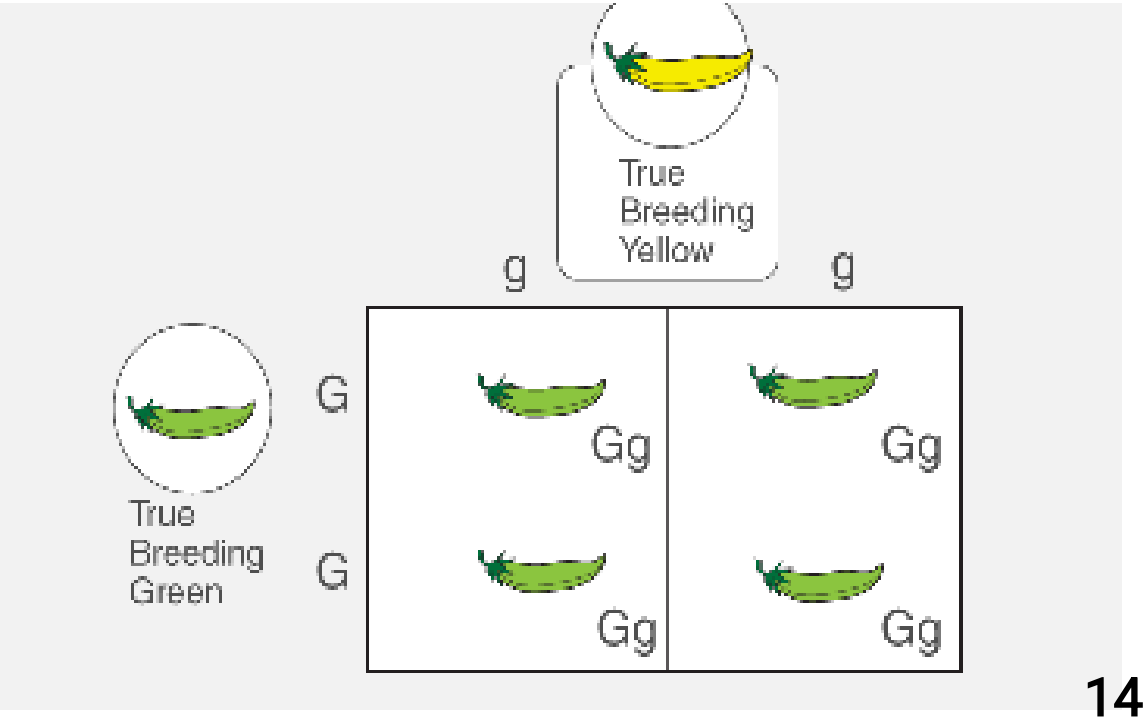


EARLY SCIENTISTS CONTRIBUTIONS

3. Law of Dominance:

- In a heterozygous individual (*with two different alleles*), one allele (**dominant**) can mask the expression of the other (**recessive**).

- **Important Note:** Mendel early contributions solved the critical puzzle of *how* traits are passed on—the missing mechanism in Lamarck and Darwin's theory.



GREGOR MENDEL AS THE FATHER OF GENETICS

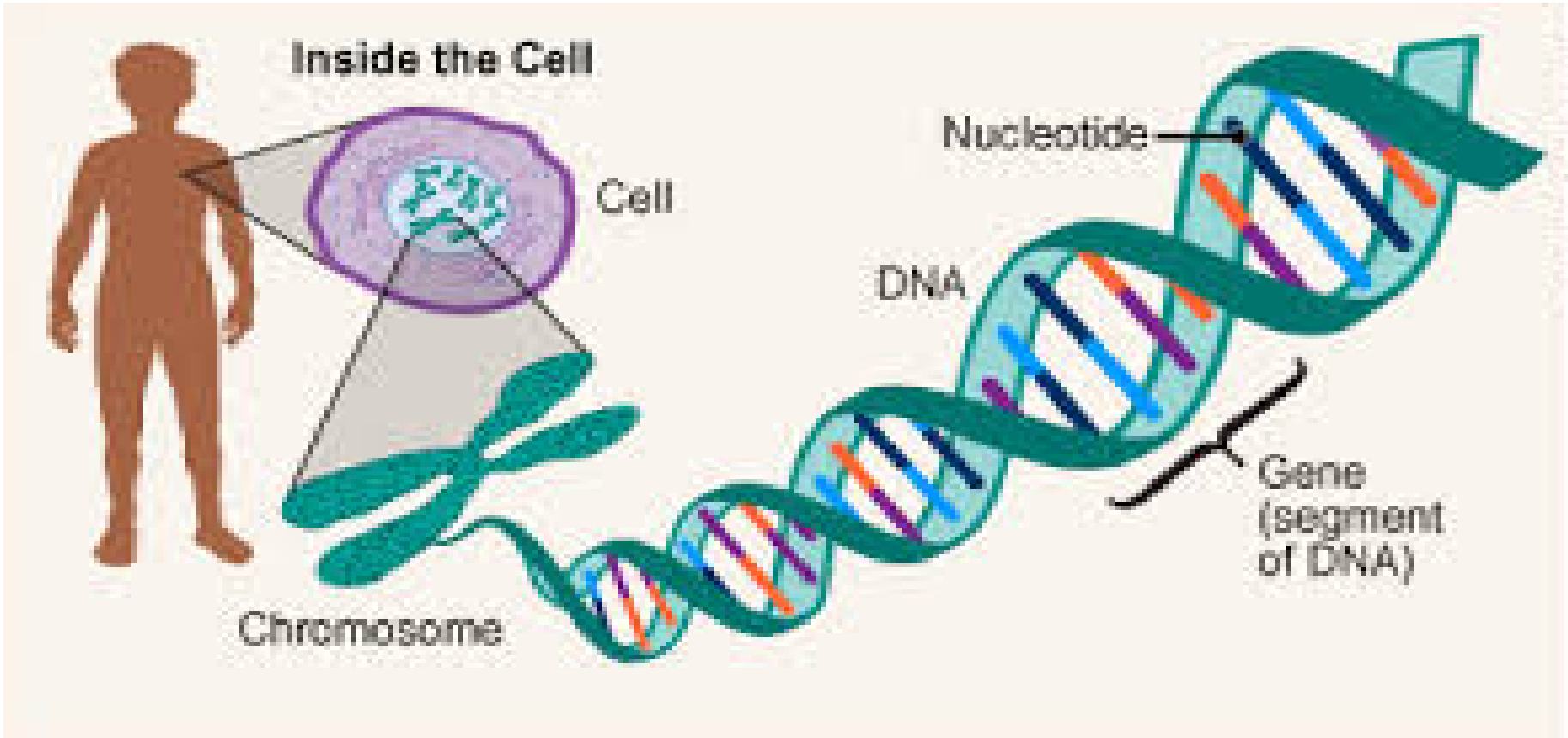
- **First to demonstrate** that traits are inherited as **discrete units** (later called "genes"), not blended.
- **Established the first mathematical, predictive laws** of inheritance through controlled experiments with pea plants.
- **Laid the experimental foundation** for all modern genetics, **though his work was unrecognised for over 30 years.**

WHAT IS GENETICS?

- **Genetics** is the scientific study of **heredity and biological variation**—how genes are passed from parents to offspring and how they influence traits.
- **Evolutionary Connection:** Genetics provides the **mechanism** for Darwin's natural selection.
  - It explains the **origin of variation** (via mutation & recombination).
  - It explains **how advantageous traits are inherited** and spread in a population.

WHAT IS GENETICS?

- **Core Principle:** Organisms inherit a set of instructions (genes) that guide development, function, and reproduction.



KEY TERMS IN GENETICS?

- **Gene:** Unit of heredity; a DNA sequence coding for a specific protein/trait.
- **Allele:** A specific variant or version of a gene (e.g., allele for blue eyes vs. brown eyes).
- **Genotype:** The genetic makeup of an individual
- **Phenotype:** The observable physical or biochemical trait
- **Homozygous:** Having two identical alleles for a gene

KEY TERMS IN GENETICS?

- **Heterozygous:** Having two different alleles for a gene
- **Dominant:** An allele that expresses its phenotype even when only one copy is present.
- **Recessive:** An allele whose phenotype is only expressed when two copies are present.
- **Important Note:** *These terms are the essential vocabulary for understanding how traits are inherited and how evolution acts on genetic variation.*

GENETIC TOOL: THE PUNNETT SQUARE

- It is a **Tool for predicting inheritance** patterns in sexual reproduction.
- It shows **probability** of offspring **genotypes** and **phenotypes**.
- It presents **visual representation** of Mendelian **segregation** and **independent assortment**.
- It can model how **allele frequencies** might change in a population over generations (microevolution).
- It can **predict possible inheritance variation** from parental crosses.

PUNNETT SQUARE DEMOS – How Inheritance Works

1. **Basic Monohybrid Cross**

Plant Trait Example: Two heterozygous pea plants for flower color (Pp × Pp) = *P is Purple, p is White*

Result: 3 Purple : 1 White phenotypic ratio

Alleles	**P**	**p**
P	**PP**	**Pp**
p	**Pp**	**pp**

PUNNETT SQUARE DEMOS – How Inheritance Works

1. **Basic Monohybrid Cross**

Human Trait Example*:* Heterozygous free earlobes × Homozygous attached earlobes (Ee × ee)

Result: 50% free earlobes, 50% attached earlobes

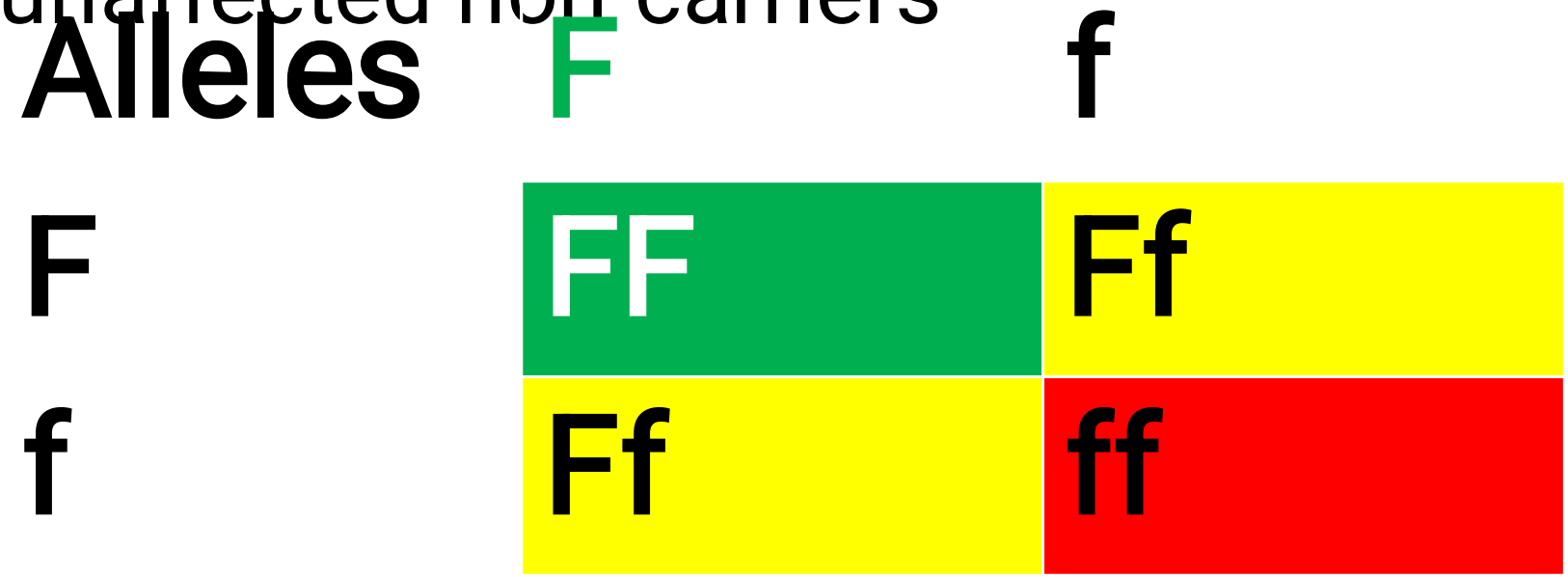
Alleles	E	e
e	Ee	ee
e	Ee	ee

PUNNETT SQUARE DEMOS – How Inheritance Works

1. **Basic Monohybrid Cross**

Disease Carrier Scenario: Two cystic fibrosis carriers (Ff × Ff)

Result: 25% affected, 50% carriers, 25% unaffected non-carriers



RECAP AND KEY SUMMARY

- **Lamarck:** Evolution by inheritance of acquired traits (largely incorrect).
- **Darwin:** Evolution by natural selection acting on variation.
- **Mendel:** Laws of inheritance explain how traits are passed.
- **Genetics + Natural Selection = Modern Evolutionary Theory.**


THANK YOU!