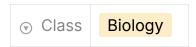


# **Chapter 17: Evolution of Populations**



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# 17.1 — Genes & Variation

# **Genetics & Evolutionary Theory**

Heritable traits are controlled by **genes** on **chromosomes**.

• Changes in the genes creates variation

**Population:** a group of individuals of the same species that mate and produce offspring

#### **Genotype & Phenotype**

Cell nuclei → Two sets of genes (one from each parent)

• Alleles (specific forms of genes) vary between individuals

**Genotype:** the particular combination of alleles an individual carries

• Genotype + environmental conditions = *Phenotype* 

**Phenotype:** all physical, physiological, and behavioral characteristics of an organism

• Natural selection acts directly on phenotype (characteristics, not alleles)

Natural selection  $\rightarrow$  differential reproductive success  $\rightarrow$  More organisms with beneficial phenotypes

#### **Populations & Gene Pools**

Gene Pool: all genes (and all alleles) present in a population

- Shared in a population due to interbreeding
- Allele Frequency: the number of times an allele occurs in a gene pool (% of the total occurrence of the allele in the gene pool)

Evolution → any change in the allele frequency in a population over time

## **Sources of Genetic Variation**

#### **Mutations**

Mutation: any change in a DNA sequence

- Changes in individual genes or longer chromosomes
- Mutations can be harmless, harmful, or beneficial

#### **Genetic Recombination in Sexual Reproduction**

Differences in heredity between people related is due to **genetic recombination**.

• Due to meiosis' shuffling of genes (crossing over)

#### **Lateral Gene Transfer**

**Lateral Gene Transfer:** the passing of genes from one individual to another that is NOT its offspring

Can occur between same or different species

# **Single-Gene and Polygenic Traits**

The number of phenotypes produced for a trait depends on **how many** genes control the trait.

#### **Single-Gene Traits**

Traits controlled by one gene depend on the number of alleles for that gene.

• Single-Gene Trait: a trait controlled by only one gene

#### **Polygenic Traits**

Polygenic Traits: traits controlled by two or more genes

· Often have two or more alleles

Phenotype + Frequency of Phenotype (graphed) → bell-shaped curve

Also known as normal distribution

# 17.2 — Evolution as Genetic Change in Populations

#### **How Natural Selection Works**

**Evolutionary Fitness:** an individual's success in passing its genes to the next generation

 Evolutionary Adaptation: any genetically-controlled trait that increases an individual's fitness

#### **Natural Selection on Single-Gene Traits**

**Directional Selection**  $\rightarrow$  a trait shifts in one direction away from the average

**Stabilizing Selection**  $\rightarrow$  individuals with average/moderate traits are more likely to reproduce

**Disruptive Selection** → individuals with extreme traits are more lkiely to reproduce than average traits

#### **Genetic Drift**

Chance occurrences can causes an allele to become more/less common

- Genetic Drift: random change in allele frequency
  - Bottleneck Effect: a change in allele frequency following a dramatic reduction in the size of a population

 Founder Effect: allele frequencies change as a result of the migration of a small subgroup of a population

# **Evolution vs. Genetic Equilibrium**

**Genetic Equilibrium** → population is not evolving (allele frequencies in the gene pool do **NOT** change)

#### **Sexual Reproduction & Allele Frequency**

A population of sexually-reproducing organisms **COULD** remain in *genetic* equilibrium.

Hypothetical idea

#### The Hardy-Weinberg Principle

**Hardy-Weinberg Principle:** allele frequencies of a population should remain constant unless one or more factors cause those frequencies to change

- $p^2 + 2pq + q^2 = 1 & p + q = 1$ 
  - p = frequency of the dominant allele
  - $\circ$  q = frequency of the recessive allele

The Hardy-Weinberg principle predicts that **5 conditions can DISTURB genetic equilibrium** (causes *evolution*):

- Nonrandom Mating → mates selected based on desired factors (sexual selection)
- Small Population Size
- Gene Flow from Immigration or Emigration 

  → Changes in allele frequency can be produced by gene flow (the movement of genes into or out of a population)
  - Immigration → introduces new alleles
  - Emigration → removes alleles
- Mutations → introduces new alleles into a gene pool
- Natural Selection

# 17.3 — The Process of Speciation

# **Isolating Mechanisms**

**Species:** a population or group of populations whose members interbreed and produce fertile offspring

- Interbreeding permits genetic changes to occur to spread throughout populations
- Once populations stop interbreeding, changes in one gene pool can't spread to others → reproductive isolation

**Speciation:** when populations evolve into two separate species

Reproductive isolation can develop in different ways:

- Behavioral Isolation → two populations that were once able to interbreed evolve different courtship behaviors
- Geographic Isolation → two populations are separates by geographic barriers (forms separate gene pools)
  - Geographic barriers DO NOT ALWAYS GUARANTEE isolation
- Temporal Isolation → two or more species reproduce at different times

# 17.4 — Molecular Evolution

## **New Genes, New Functions**

Modern genes *probably* descended from a much smaller number of genes in early life forms.

- Mutations in gene duplication during meiosis can lead to new functions of genes.
- Parts of genes can rearrange to form new genes with different functions.

# **Developmental Genes & Body Plans**

#### **Hox Genes & Evolution**

Hox genes → which part of an embryo develop into specific parts of the body

- Specific groups control the sizes and ahpes of the body parts
- Small changes in Hox genes can produce large changes in phenotype

If certain bodily events happen at different times while an embryo grows, different results can happen.

#### **Molecular Clocks**

- Uses mutation rates in DNA to estimate the time that two species have been evolving independently
- Allows scientists to mark the passage of evolutionary time

More difference between organisms → More time has elapsed since they shared a common ancestor

 Researchers estimate how often mutations occur → create different ticks for different organisms