Chapter 17: Evolution of Populations

Class	Biology

TABLE OF CONTENTS

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 → differential reproductive success → 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 → a trait shifts in one direction away from the average

Stabilizing Selection → 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
  - *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 ans 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