Section 18.1
Genes and Variation
Standards

• **LS 4.2** Using a model that demonstrates the change in allele frequencies resulting in evolution of a population over many generations, identify causative agents of change.
Key Questions

1. How is evolution defined in genetic terms?
2. What are the sources of genetic variation?
3. What determines the number of phenotypes for a given trait?
Vocabulary

• Gene pool
• Allele frequency
• Single-gene trait
• Polygenic trait
Genetics Joins Evolutionary Theory

• Heritable traits are controlled by genes carried on chromosomes.
• Changes in genes and chromosomes generate variation.
• Populations—not individual organisms—evolve over time.
Genes, Populations, and Species

• **Species**
  • A group of similar organisms that can breed with each other and produce fertile offspring
  • A population (or group of populations) of physically similar, interbreeding organisms that do not interbreed with other such groups

• **Population**
  • A group of individuals that belong to the same species and live in the same area
  • A group of individuals of the same species that mate and produce offspring
Populations and Gene Pools

• **Gene pool**- consists of all genes present in a population, including all alleles for each gene
  • Because members of a population interbreed with one another, they share a gene pool

• **Allele frequency**- the number of times an allele occurs in a gene pool, as a percentage of the total occurrence of all alleles for that gene in that gene pool
  • Allele frequency has nothing to do with whether the allele is dominant or recessive
Populations and Gene Pools

- Allele frequency in a mouse population example:
  - Black fur (B) = 20/50 = 40%
  - Brown fur (b) = 30/50 = 60%
Populations and Gene Pools

- Evolution involves any change in the frequency of alleles in a population over time.

- Populations, not individuals, evolve.
- Natural selection can act by increasing or decreasing the relative fitness of individual organisms.
- But, those individuals do not evolve during their lifetimes.
- The results of natural selection show up as changes in allele frequencies in populations over time.
Genotype, Phenotype, and Evolution

• Natural selection “selects” an organism to either survive and reproduce or to die without reproducing.

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

• Natural selection acts directly on an organism’s phenotype, not its genotype.

• Individuals with phenotypes better suited to their environment have higher fitness, produce more offspring, and pass more copies of their genes to the next generation.
Sources of Genetic Variation

- Genetic variation is produced in three main ways:
  1. Mutation
  2. Genetic recombination during sexual reproduction
  3. Lateral gene transfer
1. Mutations

• Mutation- a heritable change in genetic information

• *Neutral mutations*- mutations that do not affect phenotype (do not affect fitness)

• Mutations that do affect phenotype may or may not affect fitness.
  • May lower fitness (decrease the ability to survive and reproduce)
  • May be lethal (genetic disorder)
  • May result in adaptations that improve fitness

• Without genetic changes, a population would not have variation and would be unable to evolve.
2. Genetic Recombination During Sexual Reproduction

- Most heritable differences within families are caused by genetic recombination.
- Remember during meiosis that each gamete made contains one copy of each chromosome (23 total).
  - In humans, this can produce 8.4 million gene combinations.
- Crossing-over also produces genetic recombination.
  - Ex. you can end up with your mother’s eyes, your father’s nose, hair that combines qualities from both your parents, etc.
3. Lateral Gene Transfer

- *Lateral gene transfer*- type of gene flow where genes are passed between individuals (not parent to offspring in this case)
- Can increase genetic variation in any species that picks up “new” genes
- Common in single-celled organisms
- Ex.- bacteria swapping genes on plasmids
  - Antibiotic resistance

![Diagram of Lateral Gene Transfer](image)

FIGURE 7.19. Lateral transfer of antibiotic resistance via plasmids. (1) Antibiotic-resistant and -sensitive bacteria are shown. (2) Bacteria “mate” via conjugation, during which a copy of the plasmid carrying antibiotic resistance genes is transferred. (3) Both bacteria are now antibiotic resistant.

Single-Gene Traits

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

• Single-gene traits - a trait controlled by only one gene
  • Can only have 2 or 3 phenotypes
  • (depending on how many alleles there are for that one gene)
Polygenic Traits

- **Polygenic traits** - controlled by two or more genes
  - Often has two or more alleles for each gene
  - Many possible genotypes and phenotypes
  - Often phenotypes are not clearly distinct from one another
  - Bell-shaped curve = normal distribution
  - Ex.- human height
Section 18.1 Key Questions Exit Ticket

1. In genetic terms, what indicates that evolution is occurring in a population?

2. How do mutation, genetic recombination during sexual reproduction, and lateral gene transfer produce genetic variation?

3. What is the difference between a single-gene trait and a polygenic trait?
The End 😊