Knowledge-based Learning Outcomes

Upon completion of *Sickle-Cell Alleles*, students should be able to:

1. Describe the difference between an allele and a gene.
2. Define allele frequency.
3. State what each term in the Hardy-Weinberg equation represents, and describe how genotype frequencies are expected to change over time when a population is at Hardy-Weinberg equilibrium.
4. Understand the role of the null hypothesis.
5. Explain why deleterious alleles may persist when there is a heterozygote advantage.
6. Define fitness as the ability to survive and reproduce, and predict how differential fitness among genotypes leads to changes in allele frequencies over generations.
7. Describe in general terms the mechanism of natural selection.
8. Describe in general terms the mechanism of genetic drift.
9. Demonstrate a basic understanding of how changes in an allele's frequency depend on selection strength, population size, and the initial number of carriers of that allele.

Skills-based Learning Outcomes

Upon completion of *Sickle-Cell Alleles*, students should be able to:

1. Calculate the frequency of one allele in a two-allele system given the frequency of the other allele (i.e. demonstrate understanding that allele frequencies add up to 1.)
2. Use the Hardy-Weinberg equation to calculate the expected frequency of each genotype in a two-allele system, given the frequency of one allele.
3. Evaluate whether there is evidence for heterozygote advantage using Hardy-Weinberg equilibrium frequencies as the null hypothesis.
4. Predict how frequencies of genotypes and alleles will change under different environmental conditions when there is a heterozygote advantage.
5. Draw three graphs illustrating the effect of population size on genetic drift, and explain why alleles generally become fixed faster in smaller populations, all else being equal.