Objective: To utilize the Hardy Weinberg principle to determine if evolution is taking place in a population.

Hardy Har Har – The Hardy Weinberg equations

G. H. Hardy, an English mathematician, and W.R. Weinberg, a German physician, derived the Hardy Weinberg principle in 1908. The principle states that the frequencies of alleles and genotypes in a population's gene pool remain constant over the generations unless acted upon by agents other than sexual recombination.

When the allelic and genotypic frequencies remain constant over many generations, the population is said to be in Hardy Weinberg equilibrium. There are five qualitatively different ways that can cause a population to be out of Hardy Weinberg equilibrium. Because each is considered an evolutionary process, the occurrence of one in a population will change the allelic or genotypic frequencies in the population. As a result, populations are rarely in Hardy Weinberg equilibrium.

The five mechanisms or conditions that can cause a population to evolve and be out of Hardy Weinberg equilibrium are

Mechanisms of Change

1. **Gene flow** – Migration of individual's alleles into or out of the population.
2. **Mutations** – Spontaneous change of alleles within a population.
3. **Natural Selection** – Differential success of one allele over one another
4. **Nonrandom mating** – Preferential mating of certain phenotypes or allele combinations over others.
5. **Genetic drift** – Random change in a small gene pool due to sampling errors in propagation of alleles.

Conditions

1. Isolation from other populations
2. No net mutations
3. No natural selection
4. Random mating
5. Very large populations

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The Hardy Weinberg equation enables us to calculate theoretical frequencies of alleles in a gene pool if we know frequencies of genotypes and vice versa. Below are the two equations that can be used together in order to calculate the frequencies.

Since there are only two alleles in the population, frequency of these two alleles added together should represent 100 percent of the population or 1 when calculating frequency. For the sake of convenience, "p" can represent the frequency of the dominant allele while "q" can represent the frequency of the recessive allele. The first equation refers to the "**allelic**" frequency in a population.

$$p + q = 1$$

Frequency of the dominant allele → p

Frequency of the recessive allele → q

$$p^2 + 2pq + q^2 = 1$$

Frequency of Homozygous Dominant Genotype → p^2

Frequency of Heterozygous Genotype → $2pq$

Frequency of Homozygous Recessive Genotype → q^2

The second equation includes variables that represent the frequencies of the **genotypes** in a population. When an individual inherits a dominant allele from both parents, the variable representing this genotype is p^2. In contrast, the q^2 variable represents the homozygous recessive genotype.

There are two different ways to inherit the heterozygous genotype. An individual can inherit a "L" from the father and a "l" from the mother, or they can inherit a "l" from the father and a "L" from the mother. As result, the "2pq" portion of the equation represents the frequency of the heterozygous genotype.

After each of the allelic and genotypic frequencies is calculated, the percentages of each in the population can be determined. For example, when $q^2 = 0.7523$, it can be predicted that 75.23% of the population has the homozygous recessive genotype. If the percent of homozygous recessive individuals in a population is 95%, then one would know that the population was in fact not in Hardy Weinberg equilibrium and must be experiencing some sort of evolution over many generations.