What is Hardy-Weinberg law?

Hardy-Weinberg law, an algebraic equation that describes the genetic equilibrium within a population based on the principle that : *in a large, random-mating population, the proportion of dominant and recessive genes present tends to remain constant from generation to generation unless outside forces act to change it.*.

The outside forces that can disrupt this natural equilibrium are selection, mutation, and migration. The discovery of this law proved that natural selection as the primary mechanism of evolution. If the proportions of gene forms in a population do not change, the rate of evolution will be zero. Individual variations occur because of the various genetic combinations that result from random mating of individuals, but non-random, or selective, mating must occur for natural selection to take place. Certain gene-controlled traits are selected for or selected against by the partners involved. Over a long period of time, this selective pressure will change the frequency of appearance of certain gene forms, and the traits they control will become very common or rare in the population.

How the law is used in population genetics? Hardy-Weinberg law is used to calculate the probability of human matings that may result in defective offspring. The law is also useful in determining whether the number of harmful mutations in a population is increasing as a result of radiation from industrial processes, medical techniques, and fallout.

Mathematical formulation of Hardy-Weinberg law Thus evolution is defined as the sum total of the genetically inherited changes in the individuals who are the members of a population's gene pool. Or else, evolution is simply a change in frequencies of alleles in the gene pool of a population. For instance, let us assume that there is a trait that is determined by the inheritance of a gene with two alleles--B and b. If the parent generation has 92% B and 8% b and their offspring collectively have 90% B and 10% b, evolution has occurred between the generations. The entire population's gene pool has evolved in the direction of a higher frequency of the b allele--it was not just those individuals who inherited the b allele who evolved. This definition of evolution was developed by **Godfrey Hardy**, an English mathematician, and **Wilhelm Weinberg**, a German physician. The law operates on the condition that, the following never occurs in apopulation.

1. mutation is not occurring
2. natural selection is not occurring
3. the population is infinitely large

4. all members of the population breed
5. all mating is totally random
6. everyone produces the same number of offspring
7. there is no migration in or out of the population

They developed a simple equation that can be used to discover the probable genotype frequencies in a population and to track their changes from one generation to another. This has become known as the **Hardy-Weinberg equilibrium equation**. In this equation ($p^2 + 2pq + q^2 = 1$), p is defined as the frequency of the dominant allele and q as the frequency of the recessive allele for a trait controlled by a pair of alleles (A and a). In other words, p equals all of the alleles in individuals who are homozygous dominant (AA) and half of the alleles in people who are heterozygous (Aa) for this trait in a population. In mathematical terms, this is

$p = AA + ½Aa$

Likewise, q equals all of the alleles in individuals who are homozygous recessive (aa) and the other half of the alleles in people who are heterozygous (Aa).

$q = aa + ½Aa$

Because there are only two alleles in this case, the frequency of one plus the frequency of the other must equal 100%, which is to say

$p + q = 1$

There were only a few short steps from this knowledge for Hardy and Weinberg to realize that the chances of all possible combinations of alleles occurring randomly is

$(p + q)^2 = 1$ or more simply $p^2 + 2pq + q^2 = 1$

In this equation, p^2 is the predicted frequency of homozygous dominant (AA) people in a population, $2pq$ is the predicted frequency of heterozygous (Aa) people, and q^2 is thepredicted frequency of homozygous recessive (aa) ones.

From observations of phenotypes, it is usually only possible to know the frequency of homozygous recessive people, or q^2 in the equation, since they will not have the dominanttrait. Those who express the trait in their phenotype could be either homozygous dominant (p^2) or heterozygous ($2pq$). The Hardy-Weinberg equation allows us to predict which ones they are. Since $p = 1 - q$ and q is known, it is possible to calculate p as well. Knowing p and q, it is a simple matter to plug these values into the Hardy-Weinberg equation ($p^2 + 2pq + q^2 = 1$). This then provides the predicted frequencies of all three genotypes for the selected trait within the population.