Vocabulary of genetic variation:

Phenotype
Genotype
Locus
Allele
Haplotype

Population Genetics

**Gene Pool** - sum of all hereditary information in a population

**Gametic Pool** - all the gametes that can be produced by a population

**Gene Frequency** - portion of total number of alleles at one locus in a gene pool represented by one such allele

**Genotype Frequency** - portion of each diploid genotype in population

**Microevolution** - change in gene frequency or genotype frequency.

**Hardy-Weinberg Theorem** (1908) Describes a non-evolving population.

### A Derivation of the Hardy-Weinberg theorem

<table>
<thead>
<tr>
<th>MATING</th>
<th>FREQUENCY OF MATING</th>
<th>PROGENY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>AA</strong></td>
</tr>
<tr>
<td><strong>AA × AA</strong></td>
<td></td>
<td>$D^2$</td>
</tr>
<tr>
<td><strong>AA × AA’</strong></td>
<td></td>
<td>$2DH$</td>
</tr>
<tr>
<td><strong>AA × A’A’</strong></td>
<td></td>
<td>$2DR$</td>
</tr>
<tr>
<td><strong>AA’ × AA’</strong></td>
<td></td>
<td>$H^2$</td>
</tr>
<tr>
<td><strong>AA’ × A’A’</strong></td>
<td></td>
<td>$2HR$</td>
</tr>
<tr>
<td><strong>A’A’ × A’A’</strong></td>
<td></td>
<td>$R^2$</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>$(D + H + R)^2 = 1$</td>
</tr>
</tbody>
</table>

Note: $D =$ initial frequency of $AA$, $H =$ that of $AA’$, $R =$ that of $A’A’$; $D + H + R = 1$.

The progeny totals are calculated by recognizing that $p = D + \frac{1}{2}H$, $q = \frac{1}{2}H + R$. 
Assumptions of the Hardy-Weinberg Theorem

1. The population is composed of a very large number of sexually reproducing diploid individuals (theoretically infinitely large).

2. Mating is completely at random, including selfing in random amount; this implies that each gamete of one sex has an equal chance of uniting with any gamete of the opposite sex.

3. Both alleles are adaptively neutral, i.e., there is no selection for or against either allele; all genotypes have equal viability and leave progeny directly in proportion to their respective frequencies.

4. The population is closed; no immigration into, nor emigration from the population is allowed.

5. Mutation from one allelic state to another is disallowed.

6. Generation overlap does not exist.

7. All members of the population are equivalent reproductive age.

8. Meiosis is completely normal so that chance is the only factor operative in gametogenesis and segregation of alleles into functional gametes.

9. Allele frequencies are identical in males and females of the population.

10. Parents make equal contributions to the heredity of their offspring.

Conclusions from the Hardy-Weinberg Theorem

Gene frequencies do not change from generation to generation.

A single generation of random mating establishes binomial genotype frequencies (D, H, R) and neither these frequencies nor the allele frequencies (p, q) will change in subsequent generations.

The Hardy-Weinberg equation describes a non-evolving population, which is called Hardy-Weinberg equilibrium.

Generally, a population can be said to be in Hardy-Weinberg equilibrium if actual values for genotype frequencies match those calculated from the Hardy-Weinberg equation using observed values for allele frequencies.