

Hardy-Weinberg Equilibrium

Describes the fixed equilibrium of an allele frequency in a simple population free of evolutionary forces.

Hardy-Weinberg Equilibrium

Assumptions

- Large population size
- No migration
- No mutation
- No selection
- Random mating
- Diploid organism
- Sexual reproduction
- Equal allele frequencies in the sexes
- Non-overlapping generations

Hardy-Weinberg Equilibrium

- Population will return to equilibrium after a disturbance given all the assumptions for HWE are met.

Hardy-Weinberg Equilibrium

Allele frequencies

Given a biallelic system (Aa):

$p = A$ allele frequency

$q = a$ allele frequency

$$p + q = 1.0$$

Hardy-Weinberg Equilibrium

Genotype frequencies

		A	♀	a	
	A	AA (p^2)	Aa (pq)		AA = p^2 Aa = $2pq$
♂	a	Aa (pq)	Aa (q^2)		Aa = q^2

Hardy-Weinberg Equilibrium

Testing HWE using chi-squared test

$$\chi^2 = \sum \frac{(\text{obs freq} - \text{exp freq})^2}{\text{exp freq}}$$

Hardy-Weinberg Equilibrium

What does it mean if it is not in HWE?

- Too many homozygotes
 - Null alleles (Dankin & Avise 2004)
 - Allelic dropout (Wattier et al. 1998)
 - Inbreeding
 - Wahlund effect –subpopulations that do not interbreed
 - Loci under selection

Hardy-Weinberg Equilibrium

What does it mean if it is not in HWE?

- Too many heterozygotes
 - Isolate breaking –subpopulations interbreed temporarily reducing homozygosity
 - Overdominant selection

Linkage Disequilibrium

Non-random association of alleles
at different loci

Linkage Disequilibrium

- Correlation between alleles in a population
- Causes
 - Shared history
 - Shared recombination
 - Selection
- LD will decay over time given random mating and recombination
- *Not to be confused with linkage (physically connected on the same chromosome).*

Linkage Disequilibrium

$$D = x_{11} - p_1 q_1$$

- Haplotype frequencies:

$$A_1 B_1 : x_{11}$$

$$A_2 B_2 : x_{22}$$

$$A_1 B_2 : x_{12}$$

$$A_2 B_1 : x_{21}$$

- Allele frequencies:

$$A_1 = p_1 \quad B_1 = q_1$$

$$A_2 = p_2 \quad B_2 = q_2$$

- The difference between the observed and expected frequencies.

Linkage Disequilibrium

- If loci are in HWE
 - Calculate using allele frequencies
- If loci are not in HWE
 - Calculate using genotype frequencies

Linkage Disequilibrium

What does it mean if it is in LD?

- LD in the founding population
- It is an admixture of populations with different allele frequencies
- Selection

Programs to Calculate HWE and LD

- Arlequin
- DnaSP
- Popgene
- Genepop
- GDA
- And many more