Population Genetics

BIO 150L

Population Genetics

- At its very basic level, evolution is change in the frequencies of alleles in a population.

Mathematical model

- Look at population as a whole
- Consider the **"Gene Pool"**
  - All the genes in a population, taken as a whole

Calculating the Gene Pool

- Frequency of AA f(AA) = 0.4
- f(Aa) = 0.3
- f(aa) = 0.3

- f(A) = 0.4 + (0.3/2) = 0.55
- f(a) = 0.3 + (0.3/2) = 0.45

- f(A) + f(a) = 0.55 + 0.45 = 1

Calculating the Gene Pool

- AA = 52 individuals
- Aa = 36 individuals
- aa = 28 individuals

- f(A) = 2(52) + 36 / 2(116) = 0.6
- f(a) = 2(28) + 36 / 2(116) = 0.4

- f(A) + f(a) = 0.6 + 0.4 = 1

Frequency of Genes in Gene Pool

- "p" = frequency of dominant allele
- "q" = frequency of recessive allele

- p + q = 1

Consider the gene pool

- If the probability of an "F" is 0.3 (p = 0.3)
- And the probability of an "f" is 0.7 (q = 0.7)
- What is the probability of getting one F and a second F?

FF - probability

- 0.3 x 0.3 = 0.09
- In other words p x p, or p^2
- So the probability of an individual with the genotype FF is p^2
- Now, what is the probability of getting one f and a second f?

ff – probability

- 0.7 x 0.7 = 0.49
- In other words q x q, or q^2
- So the probability of an individual with the genotype ff is q^2
- Now, what is the probability of getting a F and a f, in **any** order?

Ff – probability

- There are two different ways to get F and f.
- So (0.3 x 0.7) + (0.7 x 0.3) = 0.21 + 0.21 = 0.42
- In other words 2 x p x q, or 2pq
- So the probability of getting an individual with the genotype Ff is 2pq.

Hardy-Weinberg Equation

- **$p^2 + 2pq + q^2 = 1.0$**
  - 0.09 + 0.42 + 0.49 = 1.0
  - What is p? What is q?

Hardy-Weinberg Equilibrium

- Under certain conditions the frequencies of genes and genotypes in a population (gene pool) will remain constant.
  - They will reach a distribution pattern of $p^2 + 2pq + q^2$ in one generation and remain there through all the following generations.
    - After one generation, no changes in allelic or genotypic frequencies
  - Population is not evolving

Where:

- p = frequency (probability) of dominant allele.
- q = frequency (probability) of recessive allele.
- p^2 = frequency of homozygous dominant
- 2pq = frequency of heterozygous
- q^2 = frequency of homozygous recessive

Hardy-Weinberg Equilibrium

- Assume a population of cats with two alleles for coat color
  - (B) – black (dominant)
  - (b) – white (recessive)

Hardy-Weinberg Equilibrium

- 16 % of the population of white coats
- 16% - bb
- q^2 = 0.16
- q = 0.4
- p = 1 – 0.4 = 0.6

Hardy-Weinberg Equilibrium

- BB = p^2 = p x p = 0.6 x 0.6 = 0.36
- Bb = 2pq = 2 x 0.6 x 0.4 = 0.48
- bb = q^2 = q x q = 0.4 x 0.4 = 0.16

Phenotypes			
Genotypes	BB	Bb	bb
Frequency of genotype in population	0.36	0.48	0.16
Frequency of gametes	0.36 + 0.24 = 0.6B	0.24 + 0.16 = 0.4b	

Hardy-Weinberg Conditions

1. Very large population size
2. Isolation from other populations – no immigration or emigration
3. No net mutations
4. Random mating
5. No natural selection

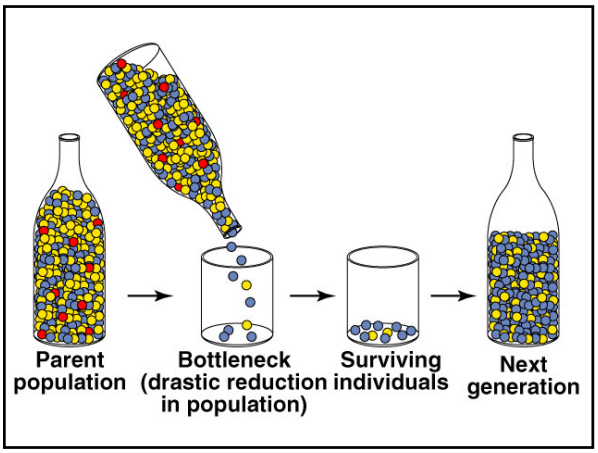
– If any conditions are not met, then populations are typically not in Hardy-Weinberg equilibrium

Five Agents of Evolutionary Change

- genetic drift (small populations)
- nonrandom mating
- mutation
- gene flow (within populations)
- natural selection

Five Agents of Evolutionary Change

- Genetic drift
  - Frequencies of particular alleles may change by chance alone.
    - important in small populations
  - Bottleneck effect



Five Agents of Evolutionary Change

- Natural Selection- nature exerts selection
  - variation must exist among individuals
  - variation must result in differences in numbers of viable offspring produced
  - variation must be genetically inherited
    - natural selection is a process, and evolution is an outcome

Five Agents of Evolutionary Change

- Selection pressures:
  - avoiding predators