- Organisms have the capacity to over reproduce
- Organisms are enormously variable in their traits
- Struggle for existence
- Environmental factors filter heritable variations
- Those best adapted will produce higher number of offspring

Fitness: the number of offspring that reproduce.

If an adaptive advantage is heritable, this leads to differential fitness.

Myxoma virus wiped out 90% of the rabbit population in 1950, but in 10 years the problem resurfaced.

Variation: difference in a given trait among organisms of the same species.

In humans, attached ear lobes are inherited as a dominant trait.

Other examples include: ability to roll the tongue, blood groups, curved little finger.

Mutation: Sudden heritable change in genetic material. The source of genetic variation. The effects range from minor alterations to lethal alleles.

Mutations that don't change the protein product are called **isoalleles.** Others may result in total loss of gene activity.

Somatic mutations: not transmitted to offspring.

Germline mutations: possibly transmitted to offspring.

Spontaneous mutations result from random errors in DNA replication, at a rate of 1 in 100,000 nucleotide pairs.

Proboscis monkey: elongated nose gave

Enzyme polymorphism: 5% of enzyme loci are heterozygous.

DNA polymorphism: DNA sequences may vary even if the enzyme products are the same.

Allele is a state of a locus. One or more alternate state of a gene.

Allele frequency: measure of occurrence of of an allele in a population.

Hardy-weinberg equilibrium

If we are given the allele frequencies, we can calculate the genotypic frequencies. Let p and q be the frequency of dominant black allele B and recessive white allele b.

$$p + q = 1$$

The probability of an individual having BB phenotype will then be

$$P(BB) = p \cdot p = p^2$$

and similarly for bb. For Bb, the probability will be,

$$P(Bb) = p \cdot q + q \cdot p$$

This analysis makes several assumptions:

- No mutation takes place.
- No immigration or emigration takes place
- Random mating occurs
- Population size is very large
- No selection occurs.

Hardy-Weinberg equilibrium principle states that a population's allele frequencies and genotypic frequencies do not change, if the above 5 criteria are satisfied.

Algorithm:

1. Calculate the phenotypic frequencies from whatever data is given.
2. From this we calculate the genotypic frequencies and then the phenotypic frequencies to see if the expected genotypic frequencies are observed; in which case, we conclude that the population is in Hardy-Weinberg equilibrium.

The factors that can cause real populations to diverge from Hardy-Weinberg equilibrium are:

- Mutation
- Non-random mating
- Gene flow
- Genetic drift
- Natural selection.

Non random mating

In self fertilizing plants, it is observed that the frequency of heterozygotes are lower than that predicted by Hardy-Weinberg equilibrium.

Mating with a genetically related individual can cause the expression of recessive genes, which can decrease the offspring viability.

Genetic drift: random changes in allele frequency.

Founder effect: change in allele frequencies caused by a few individuals.

Bottleneck effect: drastic reduction in population size.

Selection

Three major types:

1. Directional selection: selects at one end of the spectrum.
2. Disruptive or Diversifying selection: at both ends.
3. Stabilizing selection: disfavors both ends.

Infant birthweight is an example of a phenotype that undergoes stabilising selection. The mortality increases on both sides of the spectrum.

Frequency dependence

Sometimes the fitness of a trait can depend on the frequency of that trait in the population. It can be a negative or a positive dependence. In negative dependence, rare traits are favored.

Secondary sex characteristics: features that distinguish two sexes of the species other than the reproductive system.

Expensive displays express vitality and super abundance.

The goal of every organism is to increase the number of offspring that themselves reproduce.

Intrasexual selection: direct competition among individuals within a species. Usually male skewed: reproductive success of males is variable whereas not so for females.

Epigamic selection: Mate choice. One sex chooses a mate from the opposite sex.

Why are females usually the choosers? Because it is females that invest more in child rearing.

Speciation

Allopatric: geographically isolated.

Sympatric: same place.

Peripatric speciation is a special case of allopatric speciation, where one of the isolated population is so few in number that a founder's effect is observed.