GENE FREQUENCY

Gene frequency can be defined as proportion of different alleles of a gene in a population and in a particular generation these frequencies depend on their frequencies in the previous generation and also on the proportion of various genotypes in total population.

In any population, if a character is controlled by two alleles, then the frequency of these alleles or genes can be calculated very easily by phenotypic observation of that character under homozygous and heterozygous conditions. The frequency of an allele in a population is the number of occurrence of that allele divided by the total number of alleles of the gene locus.

Measurement of Gene Frequency:

In a diploid species, a population having 'N' individuals has 2N alleles for each gene locus. If there are two alleles 'A' and 'a' of a particular gene in this population, the number of A alleles is twice the number of AA homozygotes plus the number of Aa heterozygotes as each homozygote has two 'A' alleles, and each heterozygote has one 'A' allele. So, the frequency of 'A' is the number of 'A' alleles divided by total number of alleles, i.e., 2N

If the number is denoted by 'n' then the equation can be written as; $n_A = 2n_{AA} + n_{Aa}$

$n_a = 2n_{aa} + n_{Aa}$

If the frequency of allele A is denoted by 'p' then,

$$P = \frac{n_A}{2N} = \frac{2n_{AA} + n_{Aa}}{2N}$$

And, the frequency of allele a is denoted by 'q' then

$$q = \frac{n_a}{2N} = \frac{2n_{aa} + n_{Aa}}{2N}$$

For all alleles, the total frequency will be always 1 i.e. $p+q=1$ or $n_A + n_a = 2N$

For example:

In human population, a sample of 100 individuals for MN blood group character shows 50 MM, 20 MN and 30 NN individuals, then the frequency of M and N allele can be calculated using above formula:

The frequency of 'M' will be $= \frac{2\times 50 + 20}{200} = \frac{120}{200} = 0.6$.

where $2n_{MM} = 2\times 50$ $n_{MN} = 20$ $2N = 200$

The frequency of 'N' will be $= \frac{2\times 30 + 20}{200} = 0.4$

where $2n_{MN} = 2\times 30$ $n_{MN} = 20$ $2N = 200$

It can be calculated by another formula;

Frequency of a gene = Frequency of homozygotes of that gene + ½ frequency of heterozygotes

Like;

Frequency of M = 0.5 MM + ½ (0.2 MN) = 0.6

Frequency of N = 0.3 NN + ½ (0.2 MN) = 0.4

Factors Affecting Gene Frequency :-

Populations change over time. The number of individuals in a population may increase or decrease depending on food resources, climate, weather and the availability of breeding areas, etc. At the genetic level, a population may change because of mutation, migration, selection and random genetic drift. These natural processes alter allele frequencies, thereby changing the fundamental make up of the population.

Genotype Frequency :

Genotype frequency in a population is the number of individuals with a given genotype divided by the total number of individuals in the population. In population genetics, the genotype frequency is the frequency or proportion (i.e. $0 < f < 1$) of genotypes in a population. Genotype frequency may be used to predict someone's having a disease or even a birth defect. It can also be used to determine ethnic diversity.

Calculation of Genotype Frequency :- It can be computed using the binomial expansion $(p+q)^2 = 1$

The two $p+q$ terms represent male and female contributions to mating

The summation of the genotype frequencies is

$$p^2 + 2pq + q^2 = 1.0$$

Where, p^2 = frequency of AA, q^2 - frequency of aa

$2pq = 2 \times Aa$

For example, Assume in a population of rabbits, white colour is a recessive phenotype while the black is a dominant phenotype. When we observe the population, we find that there are 16 white rabbits and 84 black rabbits. i.e. The white rabbits account for 16 out of total 100 rabbits. In a percentage this is 16% or 0.16. The number is equal to q^2. Taking the square root of q^2, the allele frequency was calculated which comes out to be 0.4

Now, we can simply subtract q from 1 to find the frequency of p as

$$p + q = 1$$

$$p = 1 - q \quad ; \quad p = 1 - 0.4 = 0.6.$$