Welcome for the module from the course Molecular Biology and Evolution, ZOC 107 for the programme. Bachelors of Science for 3rd year, semester 5. Myself Dr. K. K. Therisa from Dhempe College of Arts and Science, Miramar.

The name of the module is Hardy Weinberg's Law of equilibrium from Unit 8- Genetic Basis of Evolution and Study of fossils.

Outline of the module comprised of the concept of Hardy Weinberg's Law of equilibrium, Illustration of Hardy Weinberg law of equilibrium, Significance of Hardy Weinberg's Law of equilibrium.

The learning outcome student will be able to learn the concept of Hardy Weinberg's law of Equilibrium, Illustrate Hardy Weinberg's Law of equilibrium and understand the Significance of Hardy Weinberg's Law of equilibrium.

In 1998, a British mathematician Godfrey Hardy and the German physician Willhelm Weinberg independently derived a mathematical equation. This equation representing the distribution of alleles and genotypes pertaining to a specific gene locus in a panmictic Mendelian population. Which we have already discussed in the previous unit.

Further, it was worked under certain conditions and realize the genetic structure of a population which may not change over a time. And thus established the concept of Hardy Winberg principle of equilibrium.

Hardy Weinberg's Law of equilibrium provides a theoretical framework for population genetics. The basic of population genetics has been discussed in the previous module.

Hardy Weinberg's principle states that relative frequencies of various kinds of genes in a gene pool of a large and randomly mating sexual panmictic population tend to remain constant from generation to generation, in the absence of the evolutionary forces and the evolutionary forces are such as the mutations, the natural selection and the gene flow. This principle makes an important assumption of random mating in a panmictic population.

Hardy and Weinberg discovered that under the assumption of random mating, the frequencies of alleles in the population can be used to predict the frequencies of the genotypes in that population.

For example, let's suppose in a population a gene is segregating 2 alleles. Maybe capital 'A' and small 'a'. The frequency of capital 'A' is small 'p' or variable and the frequency of small 'a' be small 'q'. If we assume the members of the population mate randomly. Then the probability of diploid genotypes of next generation will be for capital 'A' allele is small 'p' and small 'a' is small 'q'. So these are the variables which are used as a frequency. Therefore, the probability of capital 'AA' zygote, because it is a diploid genotype, the probability of a capital A has to be p x p, so it is p^2. And the probability of homozygous recessive alleles that is small 'aa' zygote is q x q that is q^2. And the probability of a heterozygous capital, 'Aa' allele will be pq, that is p x q or if it is 2pq, heterozygous condition.

The predicted genotype frequencies, that is, the p^2, 2pq and q^2. Please remember these are the Genotype frequencies, the gene or the allele frequency will be only p and q. The predicted genotype frequencies are simply in terms in the expansion of a binomial expression. That is.

$$(p + q)^2 = p^2 + 2pq + q^2$$

And this simple relationship between a genotype frequency and the allele frequencies will persist in the population If it is a randomly mating population.

Let us illustrate with the help of example Hardy Weinberg principle, let's consider a hypothetical population as an example, which is composed of 1000 individuals. Out of which 490 individuals are homozygous ‘AA’, 420 individuals are heterozygous, that is ‘Aa’ and 90 individuals are homozygous recessive ‘aa’.

First calculate the frequency of two alleles. Now are the two alleles here ‘A’ and ‘a’. And this is done by counting two types of alleles. Add these two types of alleles and divide each count by the total number of alleles in the population. The population is comprised of 1000 individuals, so, it will have a total of 2000 alleles. That means frequency of ‘A’ alone is equal to (2 X 490 + 420)/ 2000 = 0.70 = p

As we have already stated, ‘p’ is a variable given for the frequency ‘A’. So this can be considered as 70%. of the population with A. And the frequency of ‘a’ will be (2 X 90 + 420)/ 2000 = 0.30 = q

as a variable given for frequency of recessive allele. And also note that p + q answer is 1.

Now using this early frequency as we have got the early frequency p as .7 and q as .3.

Now let us predict the genotype frequencies. Early frequencies was .7 and .3. So in the next generation, let us predict what would be a genotypic frequencies and we will assume that it is under a random mating assumption. The next generation genotype frequencies will be.

AA : $p^2 = 0.49$; Aa : $2pq = 0.42$; aa : $q^2 = 0.09$

So that's in population of 1000 progeny, we predict 490 ‘AA’ , 420 ‘Aa’ and 90 ‘aa’. So using a early frequency we can easily predict genotype frequency provided.

It is a random mating assumption. And these are the same numbers we begin with, illustrating that once the Hardy Weinberg genotype frequencies have been obtained, they will persist in the population indefinitely under the absence of evolutionary forces. And if this changes. Then that indicates there are certain agents which are involved, causing the variations in the population and that is the significance of Hardy Weinberg law of equilibrium.

So let us understand the conditions for the Hardy Weinberg equilibrium:

1. It should have an extremely large population size because in small population there will be significant sampling errors and random fluctuations
2. it should be a population with random mating or Panmictic population.
3. Biparental mode of reproduction has to be there in the population because the unisexual or asexually reproducing population do not follow Hardy Weinberg law.

4. it should have a homogeneous age structure and
5. There should be a absence of evolutionary forces like natural selection, genetic drift, gene flow, etc.

And the significance of Hardy Weinberg principle is.
It provides a theoretical baseline for measuring evolutionary change. Tends to conserve gains which have been made in the past and also to avoid two rapid changes. Maintains heterozygosity in the population. Prevents evolutionary progress. Populations in nature rarely meet the stringent conditions necessary to maintain them At Hardy Weinberg equilibrium. Next point is it seems it means Hardy Weinberg principle is essential to determine whether the population is evolving or not. In order to ascertain that the evolutionary agents are operating or not, the allele and genotype frequencies of the population are determined generation after generation and then compared and the pattern of deviation from Hardy Weinberg ratio will tell the agent or the agents which are responsible for the evolutionary change.

These are the references which are used to prepare this module.

Thank you.