

HARDY-WEINBERG LAW

Represented by

Jasoda Majhi

Lecturer in Zoology

Basudev godabari degree college

Kesaibahal, Sambalpur

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INTRODUCTION:

- ❖ Use the Hardy Weinberg equation to calculate allelic and genotypic frequencies in a population.
- ❖ The Hardy-Weinberg principle states that a population's allele and genotype frequencies will remain constant in the absence of evolutionary mechanisms.
- ❖ Ultimately, the Hardy-Weinberg principle models a population without evolution under the following conditions:
 - ❖ no mutations
 - ❖ no immigration/emigration
 - ❖ no natural selection

- ❖ no sexual selection
- ❖ a large population
- ❖ Although no real-world population can satisfy all of these conditions, the principle still offers a useful model for population analysis.

❖ **Hardy-Weinberg Equations and Analysis:**

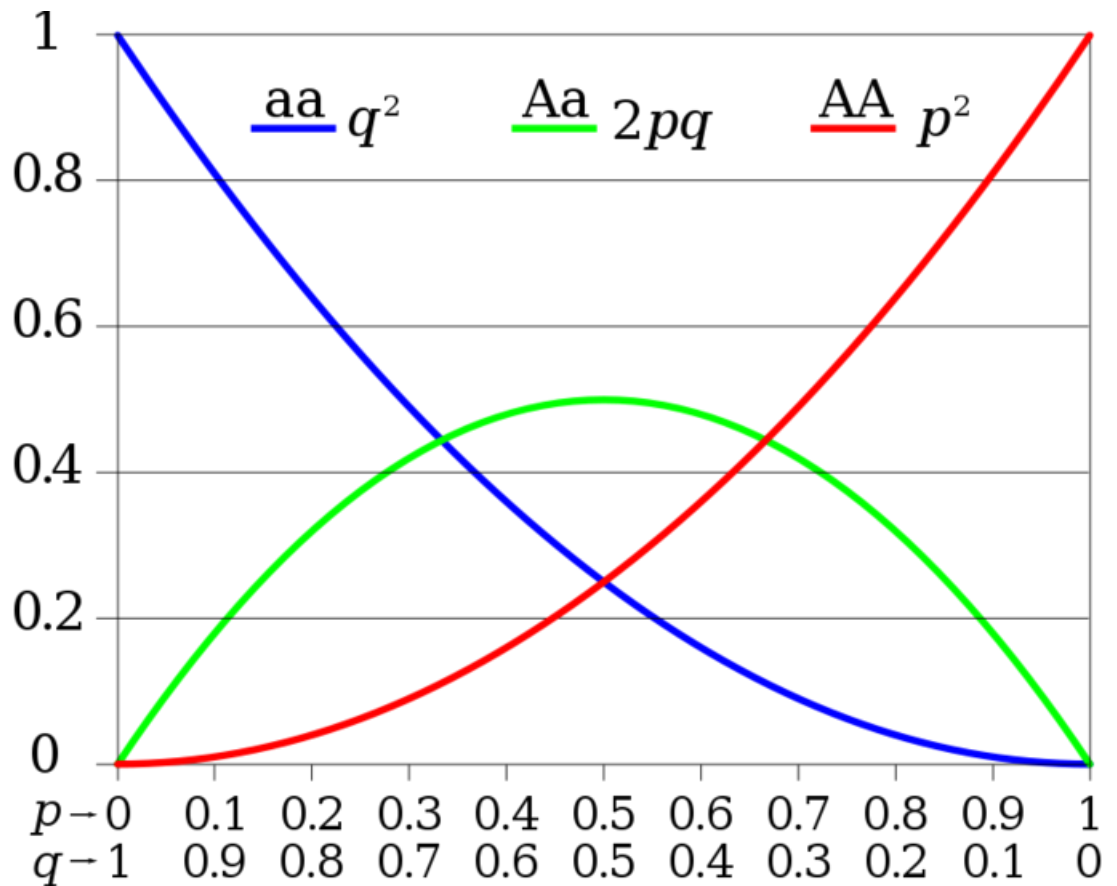
- ❖ According to the Hardy-Weinberg principle, the variable p often represents the frequency of a particular allele, usually a dominant one.
- ❖ For example, assume that p represents the frequency of the dominant allele, Y , for yellow pea pods.

- ❖ The variable q represents the frequency of the recessive allele, y , for green pea pods.
- ❖ If p and q are the only two possible alleles for this characteristic, then the sum of the frequencies must add up to 1, or 100 percent.
- ❖ We can also write this as $p + q = 1$. If the frequency of the Y allele in the population is 0.6, then we know that the frequency of the y allele is 0.4.
- ❖ From the Hardy-Weinberg principle and the known allele frequencies, we can also infer the frequencies of the genotypes.
- ❖ Since each individual carries two alleles per gene (Y or y), we can predict the

frequencies of these genotypes with a chi square.

- ❖ If two alleles are drawn at random from the gene pool, we can determine the probability of each genotype.
- ❖ In the example, our three genotype possibilities are: pp (YY), producing yellow peas; pq (Yy), also yellow; or qq (yy), producing green peas.
- ❖ The frequency of homozygous pp individuals is p^2 ; the frequency of heterozygous pq individuals is $2pq$; and the frequency of homozygous qq individuals is q^2 .
- ❖ If p and q are the only two possible alleles for a given trait in the population,

these genotypes frequencies will sum to one: $p^2 + 2pq + q^2 = 1$.



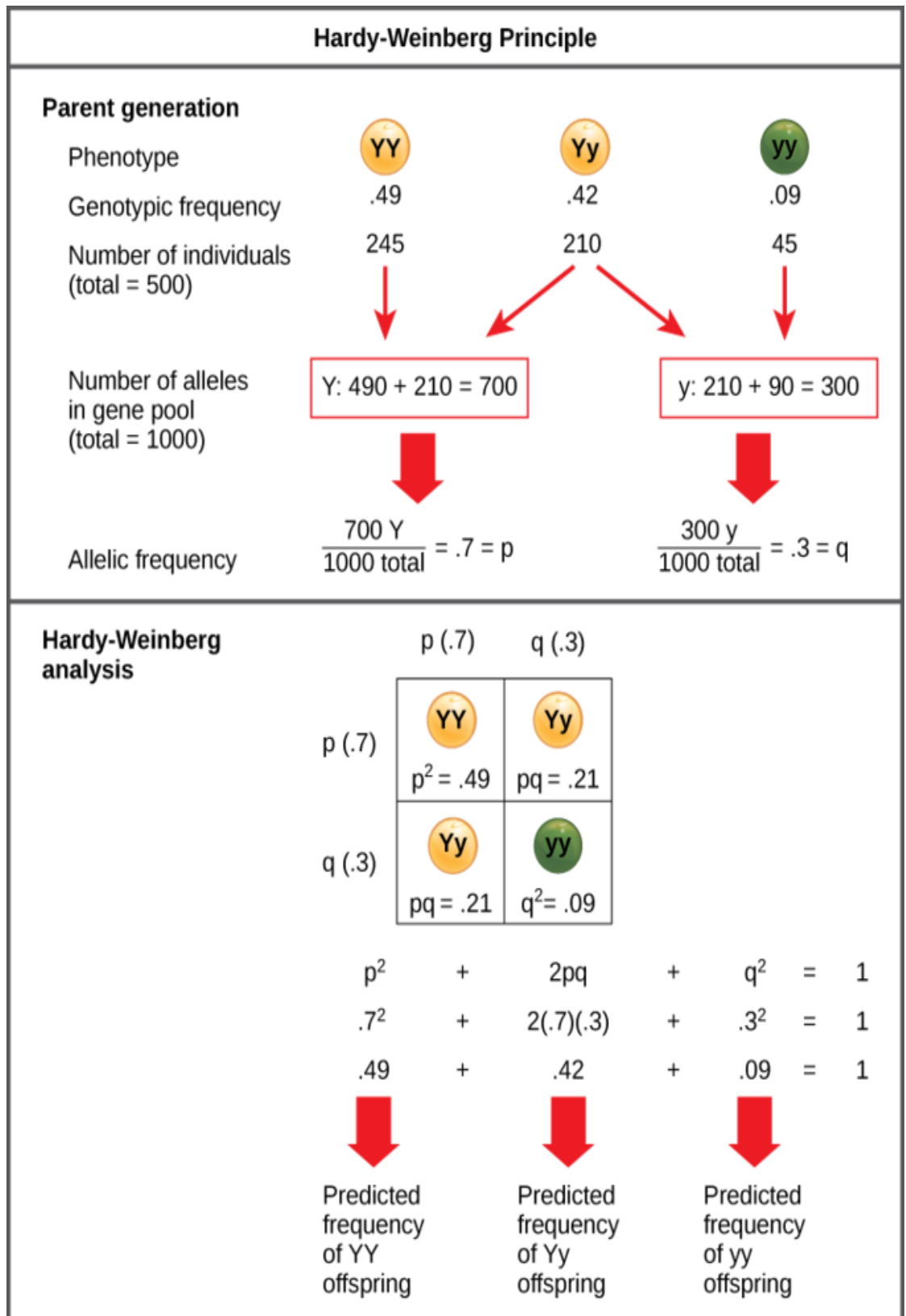
Hardy-Weinberg proportions for two alleles:

- ❖ The horizontal axis shows the two allele frequencies p and q and the vertical axis shows the expected genotype frequencies. Each line shows one of the three possible genotypes.

- ❖ In our example, the possible genotypes are homozygous dominant (YY), heterozygous (Yy), and homozygous recessive (yy).
- ❖ If we can only observe the phenotypes in the population, then we know only the recessive phenotype (yy).
- ❖ For example, in a garden of 100 pea plants, 86 might have yellow peas and 16 have green peas.
- ❖ We do not know how many are homozygous dominant (YY) or heterozygous (Yy), but we do know that 16 of them are homozygous recessive (yy).
- ❖ Therefore, by knowing the recessive phenotype and, thereby, the frequency of that genotype (16 out of 100 individuals or

0.16), we can calculate the number of other genotypes.

- ❖ If q^2 represents the frequency of homozygous recessive plants, then $q^2 = 0.16$.
- ❖ Therefore, $q = 0.4$. Because $p + q = 1$, then $1 - 0.4 = p$, and we know that $p = 0.6$. The frequency of homozygous dominant plants (p^2) is $(0.6)^2 = 0.36$.
- ❖ Out of 100 individuals, there are 36 homozygous dominant (YY) plants.
- ❖ The frequency of heterozygous plants ($2pq$) is $2(0.6)(0.4) = 0.48$.
- ❖ Therefore, 48 out of 100 plants are heterozygous yellow (Yy).



The Hardy-Weinberg Principle:

- ❖ When populations are in the Hardy-Weinberg equilibrium, the allelic frequency is stable from generation to generation and the distribution of alleles can be determined.
- ❖ If the allelic frequency measured in the field differs from the predicted value, scientists can make inferences about what evolutionary forces are at play.



Applications of Hardy-Weinberg:

- ❖ The genetic variation of natural populations is constantly changing from genetic drift, mutation, migration, and natural and sexual selection.

- ❖ The Hardy-Weinberg principle gives scientists a mathematical baseline of a non-evolving population to which they can compare evolving populations.
- ❖ If scientists record allele frequencies over time and then calculate the expected frequencies based on Hardy-Weinberg values, the scientists can hypothesize the mechanisms driving the population's evolution.
- ❖ The Hardy-Weinberg principle assumes that in a given population, the population is large and is not experiencing mutation, migration, natural selection, or sexual selection.

- ❖ The frequency of alleles in a population can be represented by $p + q = 1$, with p equal to the frequency of the dominant allele and q equal to the frequency of the recessive allele.
- ❖ The frequency of genotypes in a population can be represented by $p^2 + 2pq + q^2 = 1$, with p^2 equal to the frequency of the homozygous dominant genotype, $2pq$ equal to the frequency of the heterozygous genotype, and q^2 equal to the frequency of the recessive genotype.
- ❖ The frequency of alleles can be estimated by calculating the frequency of the recessive genotype, then calculating the square root of that frequency in order to

determine the frequency of the recessive allele.

- ❖ **Genotype:** the combination of alleles, situated on corresponding chromosomes, that determines a specific trait of an individual, such as “Aa” or “aa”
- ❖ **phenotype:** the appearance of an organism based on a multifactorial combination of genetic traits and environmental factors, especially used in pedigrees.

THANK YOU.