# Oligogenic and Polygenic Characters

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**Abstract**

Enormous progress has been made in this century about our knowledge of understanding of genetics and the rate of change is ever-increasing. Genetics has been fortunate in drawing the attention of exceptionally gifted individuals from all areas of science, including biology as well as chemistry, physics and mathematics. As a result, genetics has holding a central position in biology in the late $20^{th}$ century. Insight has been gained from studying the inheritance, function and more recently, the molecular structure of individual genes from Mendel's work to that of modern molecular geneticists. Such methods rely on the existence of clearly recognisable or having distinct phenotypes resulting from various forms of a gene or by a number of genes across individuals within a species or between species. To discover more about that target trait in that target species, it's critical to have knowledge of the underlying polygenic or oligogenic nature.

**Keywords:** Characters, Oligogenic and Polygenic

## I. OLIGOGENIC CHARACTERS

### Introduction to Oligogenic Characters

Any feature of an individual that exhibits heritable variation is referred to as a trait. It consists of behavioural, physiological, biochemical, and morphological features. Some characters are governed by one or few genes. Such characteristics are referred to as oligogenic or qualitative characters.

### Features of Oligogenic Traits

- Oligogenic traits are governed by one or few genes and each gene has its own effect.
- Oligogenic characters exhibit discontinuous variation. Hence, they can be classified into clear-cut groups.

- Effect of individual gene is easily detectable and, therefore, such traits are also known as major gene characters.
- The statistical analysis of oligogenic variation is based on frequencies and ratios. Thus, oligogenic characters are studied in mendelian genetics.
- Oligogenic characters are little influenced by environmental variation.
- The continuous variation from one extreme to the other is not achievable in the case of qualitative characters due to discrete or discontinuous change.
- In case of oligogenic characters, the gene action is primarily of non-additive type (dominance and epistasis).
- In case of oligogenic characters only the counting of plants with regard to various kinds like colour and shape is possible. Thus, metric measurement is not possible.
- Transgressive segregants are not possible in case of qualitative or oligogenic traits.

**Assumptions of Oligogenic Character**

- The dominant genes should be those that affect how characters are expressed.
- Environmental factors have no impact on qualitative characters.
- Analysis is only performed in terms of ratios and frequencies.

**Analysis of Oligogenic Traits**

- It is very easy to classify the plant population into different classes for qualitative characters.
- Estimates worked out from data recorded in an experiment analysed in terms of frequencies or ratios.

**Examples of Oligogenic Characters**

- Colour of stem
- Colour of flower
- Colour of pollen
- Seed shape, etc.

## II. POLYGENIC CHARACTERS

### Introduction to Polygenic Characters

On the other hand, some traits are governed by a number of genes. They are referred to as polygenic or quantitative characters. The mode of inheritance of polygenic characters is termed as polygenic inheritance or quantitative inheritance. Since in polygenic inheritance several genes (factors) are involved, it is also known as multiple factor inheritance.

**Features of Polygenic Traits**

- Multiple separate genes work together to control each polygenic trait, and each gene has an additive influence.
- Rather than discontinuous variation, polygenic traits show continuous variation. They therefore, cannot be categorised into distinct groupings.
- Polygenic traits are also referred to as minor gene characters since the effects of individual genes are difficult to see in the case of such features.
- Means, variances and co-variances are the basis of the statistical study of polygenic variation. Quantitative genetics thus studies polygenic traits.
- Polygenic traits are highly sensitive to environmental changes.

- The continuous fluctuation from one extreme to the other makes it impossible to divide polygenic traits into distinct, discrete groupings.
- Generally, the expression of polygenic characters is governed by additive gene action, but now cases are known where polygenic characters are governed by dominance and epistatic gene action.
- In case of polygenic characters, metric measurements like size, weight, duration, strength, etc. are possible.
- The distribution curve of the polygenic inheritance is bell-shaped.
- Transgressive segregants are only possible from the crosses between two parents with mean values for a polygenic character.

**Assumptions of Polygenic Characters**

- Every gene that contributes to the expression of a character has an equal impact.
- Each contributing allele affects a character's expression in a cumulative or additive manner.
- There is a lack of dominance in the genes involved in character expression. They exhibit an intermediate expression between the two parents.
- Genes at various loci do not epistasize one another.
- There is no linkage since the linkage is in equilibrium.
- The consequences on the environment are absent or may be disregarded. The last three presumptions are rarely true, though.

**Analysis of Polygenic Traits**

- It necessitates numerous character measurements, such as weight, length, width, height, and duration, rather than the categorization of individuals into groups based on colour or shape.
- Observations are recorded on several individuals and the mean values are used for genetical studies. Segregation into distinct classes in $F_2$ generation-is not obtained in the inheritance of quantitative characters. The segregants exhibit continuous range of variation from one extreme (low) to other (high) for such traits.
- The inheritance is studied with the help of mean, variances and covariance’s. These estimates can be worked out from data recorded in replicated experiment.
- Fisher (1918) was the pioneer worker to interpret the quantitative characters in terms of Mendelian genetics. The genetic study of quantitative characters can now be done using a number of biometrical approaches. Quantitative genetics, often known as biometrical genetics, is a field of study that focuses on the genetic interpretation of numerical traits.

**Examples of Polygenic Characters**

- Yield per plant
- Days to flower
- Days to maturity
- Seed size
- Seed oil content, etc.

**Differences between Polygenic and Oligogenic Characters:**

| **Polygenic traits** | **Oligogenic traits** |
|---|---|
| Governed by several genes | Governed by few genes |
| Effect of each gene is not detectable | Effect of each gene is detectable |
| Usually governed by additive genes | Governed by non-additive genes |
| Variation is continuous | Variation is discontinuous |
| Separation into different classes is not possible | Separation into different classes is possible |
| Highly influenced by environmental factors | Little influenced by environmental factors |
| Statistical analysis is based on mean, variances and co-variances | Statistical analysis is based on frequencies or ratios |

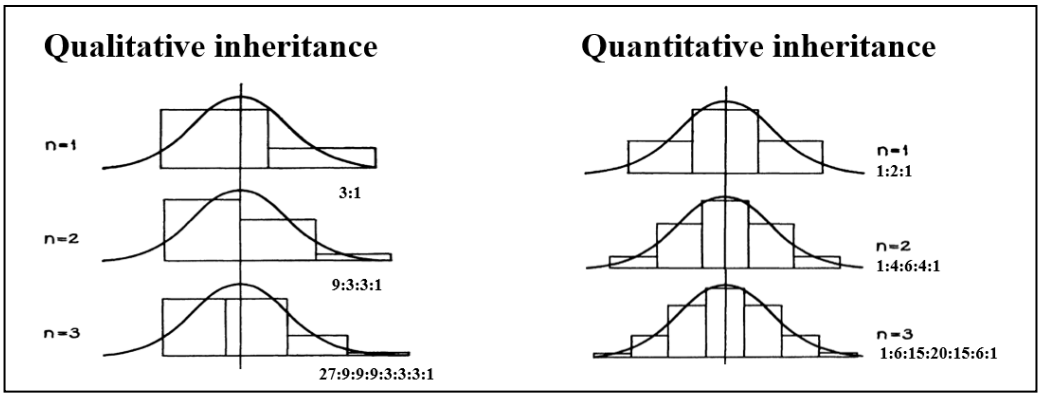


**Figure: Distribution showing Qualitative inheritance (oligogenic) and Quantitative inheritance (Polygenic) ('n' represents number of gene(s) governing the trait). (*Source*: Lush, 1943)**

**Similarities between Oligogenic and Polygenic Characters**

- Both quantitative and qualitative characters are governed by genes; the former is controlled by polygenes or minor genes and the latter by oligogene(s) or major gene(s).
- Both major as well as minor genes are located on the chromosome in the nucleus.
- The polygenic traits controlling continuous variation exhibit segregation like major genes controlling discontinuous Mendelian variation.
- Polygenic traits exhibit variable expression, which is caused by environmental factors rather than by hereditary factors. Similar to polygenic traits, qualitative traits also vary in expression, though to a lesser extent.
- The reciprocal crosses for both types of traits exhibit close agreement in expression of genes.
- The phenomenon of transgression in polygenes can only be explained by Mendelian principles of inheritance.
- Polygenes mutate like oligogenes.

- Dominance and non-allelic interactions are common features of major genes. These features are also observed for polygenes, but are usually complete for major genes and only partial for minor genes.
- Like oligogenes, polygenes display linkage. Many cases of linkage between major genes and polygenes controlling continuous variation have been reported.

Thus, quantitative genetics or biometrical genetics is an extension of Mendelian genetics firmly based on Mendelian principles of heredity.

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