**Multiple Alleles**

More than two alternative alleles of a gene are known as multiple alleles in a population occupying the same locus on a chromosome or its homologue.

1. In diploid organisms, each organism has the ability to express two alleles at the same time.
2. The alleles can be either the same (called homozygous genotype) or different (called heterozygous genotype).
3. In a haploid organism, for a gene, only one allele is present. However, when the population study is carried out for the same genes, multiple alleles for the same gene can be observed.
4. New alleles are created by a spontaneous mutation in both haploid and diploid organisms.
5. Such creation of new allelic variants also lead to the development of variation in phenotypes of the population by changing the sequence of amino acids, either in a simple or drastic way.
6. Mutations may lead to the production of variant forms of alleles, leading to multiple allelism phenomenon.
7. Multiple Alleles combine in different ways in a population which produce different kinds of phenotypes. These phenotypes are produced by the proteins encoded for various alleles.
8. Even though each gene produces its effect for the same character, the presence of different allelic forms leads to variation in the structure and functions of these proteins, which develop different phenotypes or traits.
9. Thus, multiple alleles lead to the formation of variants in the phenotypic trait of an organism.
10. When many alleles exist for the same gene, the most common phenotype or genotype in the natural population is denoted as the wild type (or ‘+‘‘+‘), and all other phenotypes or genotypes are considered as variants or mutants derived from the wild type.
11. The variants may be recessive or dominant to the wild type allele.

**Example Of Multiple Alleles**

The [ABO system](https://www.encyclopedia.com/medicine/anatomy-and-physiology/anatomy-and-physiology/abo-system) in humans is controlled by three alleles, usually referred to as IA, IB, and IO (the "I" stands for isohaemagglutinin). IA and IB are codominant and produce type A and type B antigens, respectively, which migrate to the surface of red blood cells, while IO is the recessive allele and produces no antigen. The [blood groups](https://www.encyclopedia.com/medicine/anatomy-and-physiology/anatomy-and-physiology/blood-groups) arising from the different possible genotypes are summarized in the following table.

| **Genotype** | **Blood Group** |
| --- | --- |
| IA IA | A |
| IA IO | A |
| IB IB | B |
| IB IO | B |
| IA IB | AB |
| IO IO | O |

Humans can have [red blood cells](https://www.thoughtco.com/red-blood-cells-373487) that are of type A (IA), type B (IB), or type O (i). These three different alleles can be combined in different ways following Mendel's Laws of Inheritance. The resulting genotypes make either type A, type B, type AB, or [type O blood](https://www.thoughtco.com/blood-types-373447). Type A blood is a combination of either two A alleles (IA IA) or one A allele and one O allele (IAi). Similarly, type B blood is coded for by either two B alleles (IB IB) or one B allele and one O allele (IBi). Type O blood can only be obtained with two recessive O alleles (ii). These are all examples of simple or complete dominance.

Type AB blood is an example of co-dominance. The A allele and the B allele are equal in their dominance and will be expressed equally if they are paired together into the genotype IA IB. Neither the A allele or the B allele is dominant over each other, so each type is expressed equally in the phenotype giving the human an AB blood type.