Non-Mendelian inheritance

Non-mendelian inheritance:

1) Incomplete dominance 2) Co-dominance 3) Multiple alleles 4) Pleiotropy 5) Lethality 6) Polygenic traits 7) Environmental factors

Mendel’s laws determine the distribution of phenotypes linked to single genes on a chromosome and their expected appearance in a population. In some situations, the proportion of phenotypes observed do not match the predicted values. This is called Non-mendelian inheritance and it plays an important role in several disease processes.

Non-mendelian inheritance can manifest as incomplete dominance, where offspring do not display traits of either parent but rather, a mix of both. Two alleles produce an intermediate phenotype, rather than either one exerting a specific dominance. Incomplete dominance will give a 1:2:1 phenotype ratio with the homozygous genotypes each showing a different feature and the heterozygous showing one more distinct phenotype.

An example of this is the snapdragon flower, Antirrhinum majus, which expresses white, red and pink phenotypes. A cross between a homozygous white-flowered plant CWCW and a homozygous red-flowered plant CRCR can produce pink heterozygous CRCW flowers.

Non-Mendelian Inheritance is applicable in co-dominance where two alleles may be expressed simultaneously i.e. heterozygous. There is no mixing or blending involved. The human blood type AB, where types A and B are both codominant, is an example of this. A cross between AA and BB will produce AB offspring, with both alleles being expressed equally.

Often, co-dominance is linked with a characteristic that has multiple alleles of a given gene. In many cases one of those alleles will be recessive and two others will be dominant. This gives the trait the ability to follow the Mendelian Laws of heredity with simple or complete dominance or, alternatively, to have a situation where co-dominance occurs. For example, coat colour of rabbits can appear as four common phenotypes: black CC, chinchilla CchCch, himalyan ChCh and albino cc.

In this case, the black C allele is completely dominant to all the others. The chinchilla cch is incompletely dominant to the Himalayan ch and albino c alleles. The Himalayan ch, allele is completely dominant to the albino c allele.

Non-mendelian inheritance can also manifest as pleiotropy, where one gene can affect multiple characteristics which can be seemingly unrelated. Pleiotropy can be observed in human genetic disorders such as a hereditary disorder called Marfan Sydrome. Symptoms include thin fingers and toes, heart problems, dislocation of the lense of the eye and an unusually tall height. This is caused by a mutation in a gene responsible for the production of elastic fibrils that provide flexibility and support to connective tissue and serve as storage houses for growth hormones. The amount of functional protein produced is reduced resulting in fewer fibrils due to this mutation. This leads to malfunctions in heart and eye development, as well as an overabundance of free growth hormones in the blood stream resulting in tall height.

Combinations of genes are often needed to promote the survival of organisms. If an allele that contributes to a gene is not expressed it can lead to harmful activity. This is known as lethality. A classic example of an allele that affects survival is the lethal yellow allele, a spontaneous mutation in mice that makes their coats yellow. Mice that are homozygous die early in development. Although this particular allele is dominant, lethal alleles can be dominant or recessive, and can be expressed in homozygous or heterozygous conditions.

Some characteristics are polygenic, meaning that they’re controlled by a number of different genes. In polygenic inheritance, traits often form a phenotypic spectrum rather than falling into clear-cut categories, for example skin colour.

Most real-world characteristics are determined not just by genotype, but also by environmental factors that influence how genotype is translated into phenotype. For example, hydrangea flowers vary in colour from blue to pink depending on the pH of soil they grow in.