

## Part C: Genetics

Most of the characteristics which make us an individual are due to inheritance and genetics. With the exception of identical siblings, no two individuals on Earth are genetically identical. There are small differences in how we appear to each other. These differences are described as variation. Variation arises due to sexual reproduction.

Each characteristic we possess is coded for by one or more genes. A gene is a section of DNA which contains sufficient information to code for one protein molecule / one characteristic.

Each variant of the same characteristic is known as an allele.

e.g. there are two alleles for ear lobe shape in humans, attached and unattached.

There are two types of variation within a population:

Discontinuous variation - characteristics that result in two or more distinct groups.

Continuous variation - characteristics that result in a range of values gradually changing from one extreme to another.

Each set of chromosomes, one set inherited from each parent, contains one copy of each gene. Depending on the alleles inherited, this will dictate the physical appearance or phenotype of an individual. The actual combination of genes received from each parent is known as the genotype.

If one version of an allele masks another we say the more prominent allele is dominant. The hidden or less prominent allele is recessive. If an individual has two copies of the same allele we say they are homozygous. If an individual has one copy each of two different alleles we say that they are heterozygous.

In a heterozygous individual the dominant allele will mask the recessive allele. The recessive allele will only appear in the phenotype of a homozygous individual.

If an individual comes from a true breeding population, all the offspring which they produce will have an identical phenotype to their parents.

We can predict the genotype and phenotype of offspring using a genetic cross. Where we only consider a single factor coded for by one gene, we call this monohybrid inheritance.

e.g. eye colour in fruit flies

Red eye colour (R) is dominant to white eye colour (r)

If we perform a cross of two individuals, each from a true breeding population:

|          |        |        |
|----------|--------|--------|
| Parents  | Red    | White  |
| genotype | RR     | rr     |
| gametes  | R only | r only |

cross

|   |    |    |
|---|----|----|
|   | R  | r  |
| R | RR | Rr |
| r | Rr | rr |

F<sub>1</sub> generation: phenotypic ratio 4 red : 0 white  
All individuals are heterozygous.

If we perform a self cross of two heterozygous individuals from F<sub>1</sub>:

|                           |         |         |
|---------------------------|---------|---------|
| F <sub>1</sub> generation | Red     | Red     |
| genotype                  | Rr      | Rr      |
| gametes                   | R and r | R and r |

cross

|   |    |    |
|---|----|----|
|   | R  | r  |
| R | RR | Rr |
| r | Rr | rr |

|                           |                  |                    |
|---------------------------|------------------|--------------------|
| F <sub>2</sub> generation | phenotypic ratio | 3 red : 1 white    |
|                           | genotypic ratio  | 1 RR : 2 Rr : 1 rr |

In nature we rarely observe an exact phenotypic ratio of 3 dominant allele to 1 recessive allele as the result of a heterozygous monohybrid cross. The larger the sample size, the more likely we are to be closer to the expected ratio.

Family trees may be used to trace the inheritance of dominant and recessive alleles through generations.

Co-dominance arises in genetics when two alleles for the same gene show equal dominance. In a heterozygous individual both alleles are expressed in the phenotype of the individual. Human ABO blood groups are an example of co-dominant alleles.

Discontinuous variation arises as a result of monohybrid inheritance - where a single gene may present as one of two potential alleles.  
e.g. eye colour in fruit flies.

Continuous variation arises as a result of polygenic inheritance. The alleles of more than one gene interact together to dictate the phenotype of an individual. e.g. maize kernel colour.

Environmental factors combined with genetic inheritance dictate the physical appearance or phenotype of an individual. This can be observed in twin studies.

- e.g. Identical twins share the same genetic information. If one twin does not receive sufficient nutrition when young, they may not grow to their full potential height when compared to their sibling fed a healthy diet.

Natural selection is the name given to the process that results in the survival of the fittest or the organism best suited to its environment. Those individuals less well suited to their environment are less likely to survive to breeding age and pass on their genes.

- e.g. Peppered moths in industrial and rural areas.