When organisms evolve its not only their visible, internal and external features that change, **but also the molecules of which they are made. DNA determines the proteins of an organism. It follows that changes in the features of a species are due to changes in its DNA.**

Comparison of observable characteristics:

This method is based on the fact that each observable characteristic is determined by a gene or genes (with environmental influences). The variety within a characteristic depends on the number and variety of alleles of that gene (plus environmental influences).

This has its limitations because a large number of these are coded for by more than one gene. They are poly genic. This means they are not discrete from one another but rather vary continuously. Often difficult to distinguish one from another and characteristics can also be modified by the environment. Because of this, its been replaced with comparing DNA sequences themselves.

Comparison of DNA base sequences:

Using various techniques we can now accurately determine the exact order of nucleotides on DNA. **In computer systems, each nucleotide base can now be tagged with a colour: adenine (green), thymine (red), cytosine (blue), and guanine (yellow). This produces a series of coloured bands each of which represents one of the four nucleotide bases.** We can measure the genetic diversity of a species by sampling the DNA of its members and sequencing it to produce a pattern of coloured bands. **Analysis of these allows us to compare one species with another or one individual from another of the same species to determine how diverse they are. Patterns are scanned by lasers to make it quicker and more accurate than the human eye.**

When one species gives rise to another species using evolution, the DNA of the new species will initially be very similar to that of the species that gave rise to it. **Due to mutations, the sequences of nucleotide bases in the DNA of the new species will change. Over time it will accumulate more differences in its DNA. As a result, we would expect species that are more closely related to show similarity in their DNA than species that are more distantly related.**

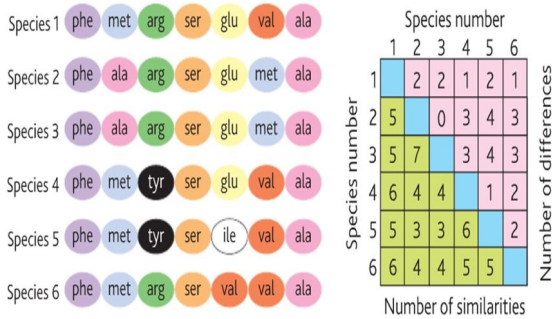
Comparison of the base sequence of mRNA:

The base sequences on mRNA are complementary to those of the strand of DNA from which they were made. We can measure DNA diversity and therefore genetic diversity by comparing the base sequence of mRNA.

Investigating Diversity

Comparison of amino acid sequences in Proteins:

Genetic diversity within and between species can be measured by comparing the amino acid sequences f their proteins as these are determined by mRNA which in turn is determined by DNA. **The degree of similarity in the sequence of the same protein in two species will also reflect how closely related they are. Once the amino acid sequence for a chosen protein has been determined for two species, they are compared. This can be done by counting either the number of similarities or differences in each sequence.**



Establishing Relationships:

Using graphs to compare data.

Immunological comparison of proteins:

The principle behind this method is the fact that antibodies of one species will respond to specific antigens on proteins. Such as albumin in the blood serum of another:

1. serum albumin from species A (human) injected into species B (rabbit)
2. Species B produces antibodies specific to all antigen sites on the albumin from species A
3. Serum is extracted from species B which contains antibodies specific to the antigens on the albumin from species A
4. Serum from species B is mixed with serum from the blood of a third species C (various other mammals)
5. The antibodies respond to their corresponding antigens on the albumin on species C
6. The response is the formation of a precipitate

The greater the number of similar antigens, the more precipitate is formed and the more closely the species ae related

The fewer the number of similar antigens, the less precipitate is formed and the more distantly the species are related.