

## Multiple Alleles and Incomplete Dominance

Up until this point, we have only discussed how alleles are distributed when there are only two traits for each characteristic and one trait is dominant over the other. For example: Pea plant height = tall (T) or short (t). But, what happens when there are more than two traits? And, what happens when one allele isn't dominant over the other?

**Multiple Alleles** - There are many cases where one gene has more than two different alleles.

For example: In Fruit Flies (*Drosophila*) there are four possible eye colours – red, apricot, honey and white. In this particular case, there is a dominance hierarchy that determines which trait is expressed. Red is dominant over all other colours, apricot is dominant over honey and white, honey is dominant over white and white is the recessive version of all four. Since there are more than two traits possible for the characteristic, we can't use uppercase and lowercase letters to represent the alleles. Instead we use a capital letter with superscript letters or numbers to express the different alleles. For example, we use a capital "E" for eye colour and then assign numbers for the four different traits. See below:

The red eye colour allele in Fruit Flies is  $E^1$ . The red eyed fly can be  $E^1E^1$ ,  $E^1E^2$ ,  $E^1E^3$  or  $E^1E^4$ .

The apricot eye colour allele in Fruit Flies is  $E^2$ . The apricot eyed fly can be  $E^2E^2$ ,  $E^2E^3$  or  $E^2E^4$ .

The honey eye colour allele in Fruit Flies is  $E^3$ . The honey eyed fly can be  $E^3E^3$  or  $E^3E^4$ .

The white eye colour allele in Fruit Flies is  $E^4$ . The white eyed fly can only be  $E^4E^4$ .

**Try Practice Questions on page 144 #1-3.**

**Incomplete Dominance** - There are many cases where two alleles are equally dominant, and one doesn't "pull rank" over the other. In these cases, an entirely new phenotype is observed when the heterozygous option is created.

Sometimes the heterozygous condition will be expressed as a blend of the two alleles – this is called **Intermediate Inheritance**. For example, if a red flower pollinates a white flower, its offspring could be pink if the colour gene exhibits intermediate inheritance.

Sometimes the heterozygous condition will cause both traits to be expressed – this is called **Codominance**. For example, if a red flower pollinates a white flower, its offspring could be red and white striped if the colour gene exhibits codominance.

When a characteristic is known to be shown as incomplete dominance, we can't use uppercase and lowercase letters to represent the alleles. This would mislead us to think that one allele is dominant over the other. Instead, we use a capital letter with superscript letters or numbers to express the different traits. In snapdragons, flower colour is an example of intermediate inheritance. So we use a capital "C" to represent the allele and then assign letters for the different traits. See below:

The red flower allele in Snap Dragons is  $C^R$ . If the flower is red, it must be  $C^R C^R$ .

The white flower allele in Snap Dragons is  $C^W$ . If the flower is white, it must be  $C^W C^W$ .

Therefore, a pink flower in Snap Dragons must be the heterozygous condition,  $C^R C^W$ .

Note: If snapdragon flower colour was expressed with codominance, then the heterozygous condition,  $C^R C^W$ , would show up as red and white stripes or spots or something of that nature.

**Try Practice Questions on page 145 #2-4, page 148-150 #2&6**

In Humans there are four different types of blood - Type A, B, AB or O. This is an example of multiple allelism. A and B alleles are also both codominant with one another, and both the A and B alleles are dominant over O. Since there are more than two traits for the blood type characteristic, and there isn't a dominance hierarchy, we use a similar system for assigning the alleles. In this case, we use the capital "I" (which stands for Immunoglobulin) as the base letter and then assign letters to represent the different traits. See below:

The Type A blood allele is  $I^A$ . A person with Type A blood is either  $I^A I^A$  or  $I^A i$ .

The Type B blood allele is  $I^B$ . A person with Type B blood is either  $I^B I^B$  or  $I^B i$ .

People with Type AB blood must have one of each allele and are  $I^A I^B$ .

The Type O blood allele is the most recessive so it is written as  $i$ . Therefore these people are  $ii$ .

*(Note: The textbook uses  $I^O I^O$  for the O blood allele. This is incorrect, and should be ignored)*

**Try the following Practice Questions**

- 1) If a person with Type AB blood has children with a person who is heterozygous for Type A blood, what are the possible phenotype and genotype options for their children?
- 2) If a person with Type O has a child with a person who is homozygous for Type A blood, is it possible for them to have a child with Type O blood? Complete the full solution to answer your question.