# Codominance in Multiple Allele Systems

The four common blood groups of the human 'ABO blood group system' are determined by three alleles: ***A***, ***B***, and ***O*** (also represented in some textbooks as: $I^A$, $I^B$, and $i^O$ or just **i**). This is an example of a **multiple allele** system for a gene. The ABO antigens consist of sugars attached to the surface of red blood cells. The alleles code for enzymes (proteins) that join these sugars together. The allele ***O*** produces a non-functioning enzyme that is unable to make any changes to the basic antigen (sugar) molecule. The other two alleles (***A***, ***B***) are **codominant** and are expressed equally. They each produce a different functional enzyme that adds a different, specific sugar to the basic sugar molecule. The blood group A and B antigens are able to react with antibodies present in the blood from other people and must be matched for transfusion.

Recessive allele: ***O*** produces a non-functioning protein
Dominant allele: ***A*** produces an enzyme which forms **A antigen**
Dominant allele: ***B*** produces an enzyme which forms **B antigen**

If a person has the ***AO*** allele combination then their blood group will be group **A**. The presence of the recessive allele has no effect on the blood group in the presence of a dominant allele. Another possible allele combination that can create the same blood group is ***AA***.

| Blood group (phenotype) | Possible genotypes | Frequency* | | |
|---|---|---|---|---|
| | | White | Black | Native American |
| **O** | *OO* | 45% | 49% | 79% |
| **A** | *AA AO* | 40% | 27% | 16% |
| **B** | | 11% | 20% | 4% |
| **AB** | | 4% | 4% | 1% |

* Frequency is based on North American population
Source: www.kcom.edu/faculty/chamberlain/Website/MSTUART/Lect13.htm

1. Use the information above to complete the table for the possible genotypes for blood group B and group AB.

2. Below are four crosses possible between couples of various blood group types. The first example has been completed for you. Complete the genotype and phenotype for the other five crosses below: