# MULTIPLE ALLELES AND BLOOD TYPES

Thus far we have treated a gene as though it could exist only in two forms, such as two alleles. However, some inheritance patterns can be explained only on the basis of multiple alleles. Multiple alleles applies to three or more alternative forms of a gene that can occupy a single locus. Each of the alleles can produce a distinctive phenotype. Among the members of a population, any given diploid individual may have any two of the alleles but never more than two in his genotype. In the population as a whole there will be distributed three or more different alleles.

Blood types in humans result from multiple alleles (3 allele system: $I^O$, $I^A$, $I^B$). Humans are placed in one of four blood groups: A, B, AB, O on the basis of tests of agglutination (clumping of red blood cells). This clumping occurs when antigens on the cells react with antibodies in the plasma.

Two different genetically determined antigens, A and B, and two different antibodies, alpha or anti-A and beta or anti-B, are known.

A person with Type A blood carries antibody beta, capable of agglutinating cells of Type B blood. In transfusions, care must be taken not to administer blood that can be agglutinated by the antibodies of the recipient.

Symbolizing genetic makeup: I indicates the gene

$I^O$ = no antigen produced; recessive to $I^A$ and $I^B$
$I^A$ = antigen A
$I^B$ = antigen B

The various blood groups are with possible genotypes:

$I^AI^O$, $I^AI^A$ = Type A blood
$I^BI^O$, $I^BI^B$ = Type B
$I^AI^B$ = Type AB (codominance)
$I^OI^O$ = Type O

Genes with more than three alleles are referred to as multiple allelic series. The genes controlling tissue rejection in the heart, liver, or kidney transplantations all have many alleles. Genes of the major histocompatibility complex encode certain proteins that appear on a cell's surface and serve as identification markers on each individual's tissues and organs helping our bodies distinguish our own cells from organisms that might invade (bacteria, viruses, parasites).

Since there are several genes in the major histocompatibility complex, each with multiple alleles, it is then very unlikely that two unrelated (or even related) persons will have precisely the same constellation of alleles at all loci. This is why a person with Kidney or liver disease must often wait a long time before becoming matched to a suitable donor. Only with transplants involving identical twins will there be no rejection.