

- Discuss the Rh blood group system in terms of: inheritance, and antigens of the system.

Inheritance of Rh blood group antigens:

The presence or absence of an *RHD* gene results in the expression or absence of the D antigen on the red cells and this determines whether individuals are D+ or D-.

A D+ person may inherit two *RHD* genes, one from each parent (homozygous) or one *RHD* gene from either parent (hemizygous).

The two pairs of antigens C and c, and E and e are controlled by the various *RHCE* genes. At the *RHCE* gene locus, depending on the allele present, one of four alternative antigenic combinations are produced, namely ce, Ce, cE or CE.

The *RHD* and *RHCE* alleles are inherited as a gene complex or haplotype. Usually one haplotype is inherited from each parent.

The presence or absence of the *RHD* gene, together with one of the four possible alleles of the *RHCE* gene, results in eight possible gene haplotypes or complexes. The Rh genotype is therefore a combination of any of the eight possible haplotypes

D+ individuals inherit two Rh genes: *RHD* coupled with one of the alleles of *RHCE* from each parent. In D- individuals, *RHD* is deleted, and individuals have the *RHCE* genes only. As a result, most D- individuals lack the total RhD protein on their red cell membrane.

Rh antigens

The Rh system is a complex system which has more than 50 antigens on the red cell membrane. The major five antigens are D, C, E, c, and e. The Rh antigens are coded for by the *RHD* and *RHCE* genes, each of which produces a separate protein that is expressed on the red cell membrane.

The RhD protein crosses the red cell membrane 12 times, giving rise to six extracellular domains. The exact function of the Rh proteins within the red cell membrane is unknown, but their structure suggests a transmembrane transporter function. In cases of the very rare type Rh-null, the absence of the Rh proteins has shown that the red cells are abnormal morphologically and individuals often suffer from some degree of haemolytic anaemia as the red cells are abnormal in shape.

Most people express D antigen. D antigen is the most immunogenic antigen of the Rh antigens and play a significant role in the haemolytic disease of the new born. The C, E, c or e antigens are far less immunogenic than D antigen.

Many people may have a weak form of the D antigen in which fewer D antigen

sites are present on the red cell as compared with a normal D+. The weak D characteristic is usually the result of the inheritance of a genetic variation. The identification of weak D in the lab by using specific monoclonal antibodies is extremely important in order to avoid the transfusion of a D- patient with mistyped weak D blood.

The term partial D is used to describe the phenotype of those rare individuals, whose red cells lack one or more of the D epitopes. If some D epitopes are missing, then the individual can make an antibody specific for the missing epitope/s if they are exposed to normal D+ cells. The produced antibody in partial D people can react with all normal D+ cells and results in transfusion reaction. A panel of epitopes specific monoclonal anti-D antibodies are now available to detect and classify partial D types.