BLOOD GROUPS:

When blood transfusions from one person to another were first attempted, typical transfusion reactions that frequently led to death often occurred. Soon it was discovered that the blood types of different people have different antigenic and immune properties so that antibodies in the plasma of one blood type will react with antigens on the surfaces of the RBCs of another blood type.

The blood groups are mainly of three types:

(1) A, B and O groups.

(2) Rh factor.

(3) M and N factors.

A, B and O Groups:

- The phenomenon of hemoagglutination is clumping of RBCs due to the interaction between antigens present on the surfaces of the RBCs (agglutinogens) and agglutinins present in the plasma (or serum). Because the agglutinins have many binding sites, a single agglutinin can attach to two or more RBCs at the same time, thereby causing the cells to be bound together by the agglutinin. This binding causes the cells to clump,
- There are two primary agglutinogens-A and B; and there are two corresponding agglutinins. The agglutinogens are inherited as mendelian dominants and they are so called because they often cause RBC agglutination .
- In transfusing blood from one person to another, the blood of donors and recipients is normally classified into four major O-A- B blood types, depending on the presence or absence of the two agglutinogens, the A and B agglutinogens.
- When neither A nor B agglutinogen is present, the blood is *type O*. When only type A agglutinogen is present, the blood is *type A*. When only type B agglutinogen is present, the blood is *type B*. When both A and B agglutinogens are present, the blood is *type AB*. When type A agglutinogen *is not present* in a person's RBCs, antibodies known as *anti-A agglutinins* develop in the plasma. Also, when type B agglutinogen *is not present* in the RBCs, antibodies known as *anti-B agglutinins* develop in the plasma.

Agglutinogens and agglutinins in ABO blood group

Group	Agglutinogens present in RBC	Agglutinins present in serum
O	O	Anti-A & Anti-B
A	A	Anti-B
B	B	Anti-A
AB	A&B	Neither Anti- A nor Anti-B

- Type O blood, although containing no agglutinogens, does contain both *anti-A* and *anti-B agglutinins*. Type A blood contains type A agglutinogens and anti-B agglutinins, and type B blood contains type B agglutinogens and anti-A agglutinins. Finally, type AB blood contains both A and B agglutinogens but no agglutinins.

- Group O can give blood to all but can take only from its own group. Group AB can take blood from all but can give blood only to its own group. Group A and B can give blood to their own groups and also to group AB and can take blood from their own groups and from group O. Other combinations are not compatible.
- The agglutinins are antibodies produced by the same bone marrow and lymph gland cells that produce antibodies to any other antigens.

Rh Blood Types: The Rh blood type system is also important when transfusing blood.

- Rh agglutinogens are present in the RBCs of 85% of White people. There is no corresponding agglutinin in the human plasma.
- There are six Rh agglutinogens: C, c; D, d; E, e.
- D and d are the commonest. These two will provide three subgroups: D, Dd and d.
- D is mendelian dominant, while d is recessive. Hence, groups D and Dd (collectively called D group) will be Rh positive (Rh +ve) and d will be Rh negative (Rh-ve).
- Practically all Rh positive people belong to D group and Rh negative people to group d.
- All Rh incompatible reactions are due to interactions between group D (donor) and group d (recipient).
- If an Rh-negative person has never been exposed to Rh-positive blood, transfusion of Rh-positive blood into that person will likely cause no immediate reaction. However, anti-Rh antibodies can develop in sufficient quantities during the next 2 to 4 weeks to cause agglutination of the transfused cells that are still circulating in the blood. These cells are then hemolyzed by the tissue macrophage system. Thus, a *delayed* transfusion reaction occurs, although it is usually mild. On subsequent transfusion of Rh-positive blood into the same person, who is now already immunized against the Rh factor, the transfusion reaction is greatly enhanced and can be immediate and as severe as a transfusion reaction caused by mismatched type A or B blood.

Erythroblastosis Fetalis (Hemolytic Disease of the Newborn):

- It is a disease of the fetus and newborn child characterized by agglutination and phagocytosis of the fetus's RBCs.
- In most cases of erythroblastosis fetalis, the mother is Rh negative and the father is Rh positive. The baby has inherited the Rh-positive antigen from the father, and the mother develops anti-Rh agglutinins from exposure to the fetus's Rh antigen. In turn, the mother's agglutinins diffuse through the placenta into the fetus and cause RBC agglutination. The agglutinated RBCs subsequently hemolyze, releasing hemoglobin into the blood. The fetus's macrophages then convert the hemoglobin into bilirubin, which causes the baby's skin to become yellow (jaundiced). The antibodies can also attack and damage other cells of the body.
- The hematopoietic tissues of the infant attempt to replace the hemolyzed RBCs. Because of the rapid production of RBCs, many early forms of RBCs, including many *nucleated blastic forms*, are passed from the baby's bone marrow into the circulatory system, and it is because of the presence of these nucleated blastic RBCs that the disease is called *erythroblastosis fetalis*.

- One treatment for erythroblastosis fetalis is to replace the neonate's blood with Rh-negative blood. Phototherapy (used to treat hyperbilirubinemia) causes photo isomerization of bilirubin in the skin to water-soluble isomers that can be excreted by the kidneys and stool without further metabolism by the liver.
- Erythroblastosis fetalis is a preventable condition. A medication called Rh immunoglobulin also known as RhoGAM, can help prevent Rh sensitization. This medication prevents the pregnant woman from developing Rh-positive antibodies by unknown mechanism. Women at risk for Rh sensitization should receive RhoGAM doses at specific times during their pregnancy (28 weeks of gestation) and after delivery.

M and N factors: Besides the A, B O system, other supplementary agglutinogens have been identified. They are known as M and N factors. This will provide three other independent groups M, N, and MN. These groups are of no importance for blood transfusion but have got medicolegal importance, e.g. paternity test.

Blood Typing: Before giving a transfusion to a person, it is necessary to determine the blood type of the recipient and donor blood so that the bloods can be appropriately matched. This process is called *blood typing* and *blood matching*.

Cross matching test (compatibility testing): is a test used to check for harmful interactions between the recipient blood and a specific donor blood.

Mismatched Blood Transfusion: The symptoms of a hemolytic transfusion reaction most often appear during or right after the transfusion. Symptoms include head, chest and flank pain, fever, chills, flushing, rigors, nausea and vomiting, urticaria, dyspnea and hypotension. The further complications include hemoglobinuria, disseminated intra-vascular coagulation, transfusion related lung injury which manifest with signs of hypoxemia, dyspnea, cyanosis, fever, tachycardia and hypotension. The hemoglobinuria may further lead to anuria and still further may progress to renal failure. Mismatched blood transfusion leads to red blood cell hemolysis which releases hemoglobin which gets converted to bilirubin producing hemolytic jaundice.