Blood Groups and Blood Transfusion

Blood groups are determined by the presence of antigen in RBC membrane. When blood from two individuals is mixed, sometimes clumping (agglutination) of RBCs occurs. This clumping is because of the immunological reactions. But why clumping occurs in some cases and not in other cases remained a mystery until the discovery of blood groups by the Austrian Scientist, Karl Landsteiner in 1901.

O-A-B Blood Types A and B Antigens—Agglutinogens Two antigens—type A and type B—occur on the surfaces of the red blood cells in a large proportion of human beings. It is these antigens (also called agglutinogens because they often cause blood cell agglutination) that cause most blood transfusion reactions. Because of the way these agglutinogens are inherited, people may have neither of them on their cells, they may have one, or they may have both simultaneously.

Major O-A-B Blood Types. In transfusing blood from one person to another, the bloods of donors and recipients are 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.

Blood Types with Their Genotypes and Their Constituent Agglutinogens and Agglutinins

Genotypes	Blood Types	Agglutinogens	Agglutinins
OO	O	—	Anti-A and Anti-B
OA or AA	A	A	Anti-B
OB or BB	B	B	Anti-A
AB	AB	A and B	—

Genetic Determination of the Agglutinogens.

Two genes, one on each of two paired chromosomes, determine the O-A-B blood type. These genes can be any one of three types but only one type on each of the two chromosomes: type O, type A, or type B. The type O gene is either functionless or almost functionless, so that it causes no

significant type O agglutinogen on the cells. Conversely, the type A and type B genes do cause strong agglutinogens on the cells. The six possible combinations of genes, these combinations of genes are known as the genotypes, and each person is one of the six genotypes. A person with genotype OA or AA produces type A agglutinogens and therefore has blood type A. Genotypes OB and BB give type B blood, and genotype AB gives type AB blood.

Relative Frequencies of the Different Blood Types. The prevalence of the different blood types among one group of persons studied was approximately:

O	47%
A	41%
B	9%
AB	3%

Agglutinins When type A agglutinogen is not present in a person's red blood cells, antibodies known as anti-A agglutinins develop in the plasma. Also, when type B agglutinogen is not present in the red blood cells, antibodies known as anti-B agglutinins develop in the plasma.

Blood Typing Before giving a transfusion to a person, it is necessary to determine the blood type of the recipient's blood and the blood type of the donor blood so that the bloods can be appropriately matched. This is called blood typing and blood matching, and these are performed in the following way: The red blood cells are first separated from the plasma and diluted with saline. One portion is then mixed with anti-A agglutinin and another portion with anti-B agglutinin. After several minutes, the mixtures are observed under a microscope. If the red blood cells have become clumped— that is, "agglutinated"—one knows that an antibody antigen reaction has resulted. Type O red blood cells have no agglutinogens and therefore do not react with either the anti-A or the anti-B agglutinins. Type A blood has A agglutinogens and therefore agglutinates with anti-A agglutinins. Type B blood has B agglutinogens and agglutinates with anti-B agglutinins. Type AB blood has both A and B agglutinogens and agglutinates with both types of agglutinins.

Characteristics of Rh Transfusion Reactions.

If an Rh-negative person has never before 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 those 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.

Rh Blood Types Along with the O-A-B blood type system, the Rh blood type system is also important when transfusing blood. The major difference between the O-A-B system and the Rh system is the following: In the O-A-B system, the plasma agglutinins responsible for causing transfusion reactions develop spontaneously, whereas in the Rh system, spontaneous agglutinins almost never occur. Instead, the person must first be massively exposed to an Rh antigen, such as by transfusion of blood containing the Rh antigen, before enough agglutinins to cause a significant transfusion reaction will develop.

Formation of Anti-Rh Agglutinins. When red blood cells containing Rh factor are injected into a person whose blood does not contain the Rh factor—that is, into an Rh-negative person—anti-Rh agglutinins develop slowly, reaching maximum concentration of agglutinins about 2 to 4 months later. This immune response occurs to a much greater extent in some people than in others. With multiple exposures to the Rh factor, an Rh-negative person eventually becomes strongly "sensitized" to Rh factor.

Erythroblastosis Fetalis ("Hemolytic Disease of the Newborn")

Erythroblastosis fetalis is a disease of the fetus and newborn child characterized by agglutination and phagocytosis of the fetus's red blood cells. In most instances of erythroblastosis fetalis, the mother is Rh negative and the father 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 red blood cell agglutination.

Effect of the Mother's Antibodies on the Fetus.

After antiRh antibodies have formed in the mother, they diffuse slowly through the placental membrane into the fetus's blood. There they cause agglutination of the fetus's blood. The agglutinated red blood cells 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.

Transfusion Reactions Resulting from Mismatched Blood Types

If donor blood of one blood type is transfused into a recipient who has another blood type, a transfusion reaction is likely to occur in which the red blood cells of the donor blood are agglutinated. It is rare that the transfused blood causes agglutination of the recipient's cells, for the following reason: The plasma portion of the donor blood immediately becomes diluted by all the plasma of the recipient, thereby decreasing the titer of the infused agglutinins to a level usually too low to cause agglutination. Conversely, the small amount of infused blood does not significantly dilute the agglutinins in the recipient's plasma. Therefore, the recipient's agglutinins can still agglutinate the mismatched donor cells. As explained earlier, all transfusion reactions eventually cause either immediate hemolysis resulting from hemolysins or later hemolysis resulting from phagocytosis of agglutinated cells. The hemoglobin released from the red cells is then converted by the phagocytes into bilirubin and later excreted in the bile by the liver. The concentration of bilirubin in the body fluids often rises high enough to cause jaundice—that is, the person's internal tissues and skin become colored with yellow bile pigment. But if liver function is normal, the bile pigment will be excreted into the intestines by way of the liver bile, so that jaundice usually does not appear in an adult person unless more than 400 milliliters of blood is hemolyzed in less than a day.