Blood Types

In order to understand blood types, it is important to understand several terms that relate to the body's **immune** functions (discussed in detail in the next chapter)

- Antigens are substances that the body does not recognize as belonging to itself ("self") and that therefore trigger a **defensive response** from the leukocytes of the immune system. Many people have antigens on the surfaces of their red blood cells. More than 50 antigens have been identified on erythrocyte membranes, but the most significant in terms of their potential harm to patients are classified in two groups: the ABO blood group and the Rh blood group.
- Antibodies are proteins which are produced by plasma cells in response to a "non-self" antigen being present in the body. Antibodies attach to the antigens on the plasma membranes of the erythrocytes in a blood transfusion and cause them to adhere to one another.
- Agglutination refers to the resulting clumps of red blood cells that are formed in such an antigen-antibody reaction. These clumps can block small blood vessels, thereby cutting of the supply of oxygen and nutrients to the tissues.
- Hemolysis, or the breakdown of the erythrocyte's cell membrane, takes place as the clumps of red cells start to degrade. The resulting release of the cell's contents, mainly hemoglobin, into the bloodstream can cause kidney failure.

ABO Blood Group

ABO blood types are **genetically** determined. Each type is determined by the presence or absence of certain antigens on the individual's red blood cell membrane, as well as the presence or absence of certain antibodies. Normally the body must be exposed to a **foreign antigen** before an antibody can be produced. This is not the case for the ABO blood group, in which some blood types come preloaded with their own set of antibodies against another type. The table below shows the ABO blood group as well as the universal donor and recipient in relation to blood transfusions.

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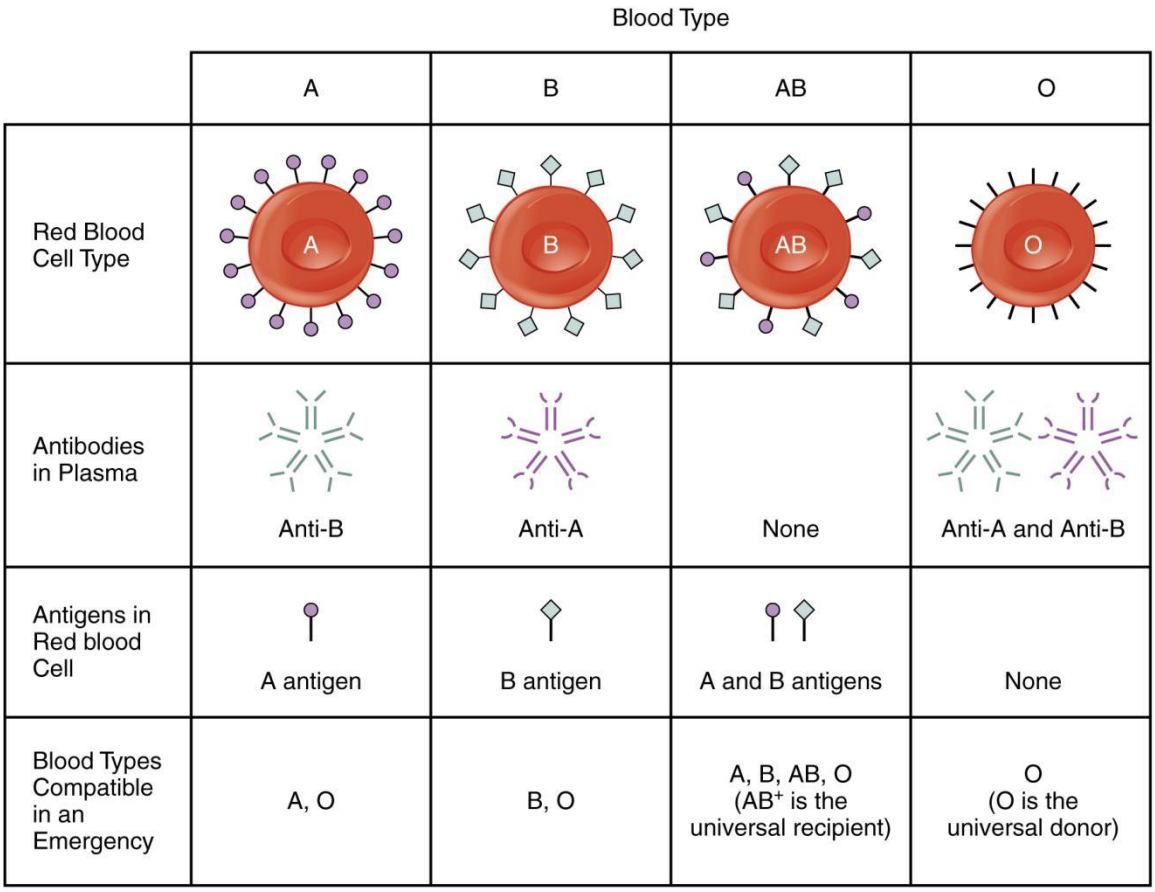

Figure 3.13 ABO Blood Groups. From Betts, et al., 2013. Licensed under CC BY 4.0.

- **Blood Type A**

  - People whose erythrocytes have **A antigens** on their erythrocyte membrane surface.
  - People who have type A blood, without any prior exposure to incompatible blood, have preformed **anti-B antibodies** circulating in their blood. These antibodies will cause a serious immune reaction if they encounter blood that has B antigens.
- **Blood Type B**
  - People whose erythrocytes have **B antigens.**
  - People with type B blood has preformed **anti-A antibodies.**

- **Blood Type AB**

  - People can also have **both A and B antigens** on their erythrocytes, in which case they are blood type AB.
  - Individuals with type AB blood, **do not have preformed antibodies** to either A or B antigens.
- **Blood Type O**

  - People with **neither A nor B antigens** are designated blood type O.

- People with type O blood have **both anti-A and anti-B antibodies** circulating in their blood plasma.

Rh Blood Group

The **Rh blood group** is classified according to the presence or absence of a second erythrocyte **antigen** identified as Rh. Those who have the Rh D antigen present on their erythrocytes are described as Rh positive (Rh+) and those who lack it are Rh negative (Rh−). Note that the Rh group is distinct from the ABO group, so any individual, no matter their ABO blood type, may have or lack this Rh antigen. When identifying a patient's blood type, the Rh group is designated by adding the word positive or negative to the ABO type. For example, A positive (A+) means ABO group A blood with the Rh antigen present, and AB negative (AB−) means ABO group AB blood without the Rh antigen.

Hemolytic Disease of the Newborn (HDN)

Antibodies to the Rh antigen are produced only in Rh− individuals after exposure to the antigen. This process, called sensitization, occurs following a transfusion with Rh-incompatible blood or, more commonly, with the birth of an Rh+ baby to an Rh− mother.

- In a **first pregnancy** problems are rare**,** since the baby's Rh+ cells rarely cross the placenta. However, during or immediately after birth, the Rh− mother can be exposed to the baby's Rh+ cells (Figure below). Research has shown that this occurs in about 13−14 percent of such pregnancies. After exposure, the mother's immune system begins to generate anti-Rh antibodies.
- In a **second pregnancy** if a mother should conceive a Rh+ baby, the Rh antibodies she has produced can cross the placenta into the fetal bloodstream and destroy the fetal RBCs. This condition, known as **hemolytic disease of the newborn (HDN)** or erythroblastosis fetalis. This may cause anemia in mild cases, but the agglutination and hemolysis can be so severe that without treatment the fetus may die in the womb or shortly after birth.

- A drug known as RhoGAM, short for Rh immune globulin, can temporarily prevent the development of Rh antibodies in the Rh− mother, thereby averting this potentially serious disease for the fetus. RhoGAM antibodies destroy any fetal Rh+ erythrocytes that may cross the placental barrier. RhoGAM is normally administered to Rh− mothers during weeks 26−28 of pregnancy and within 72 hours following birth.

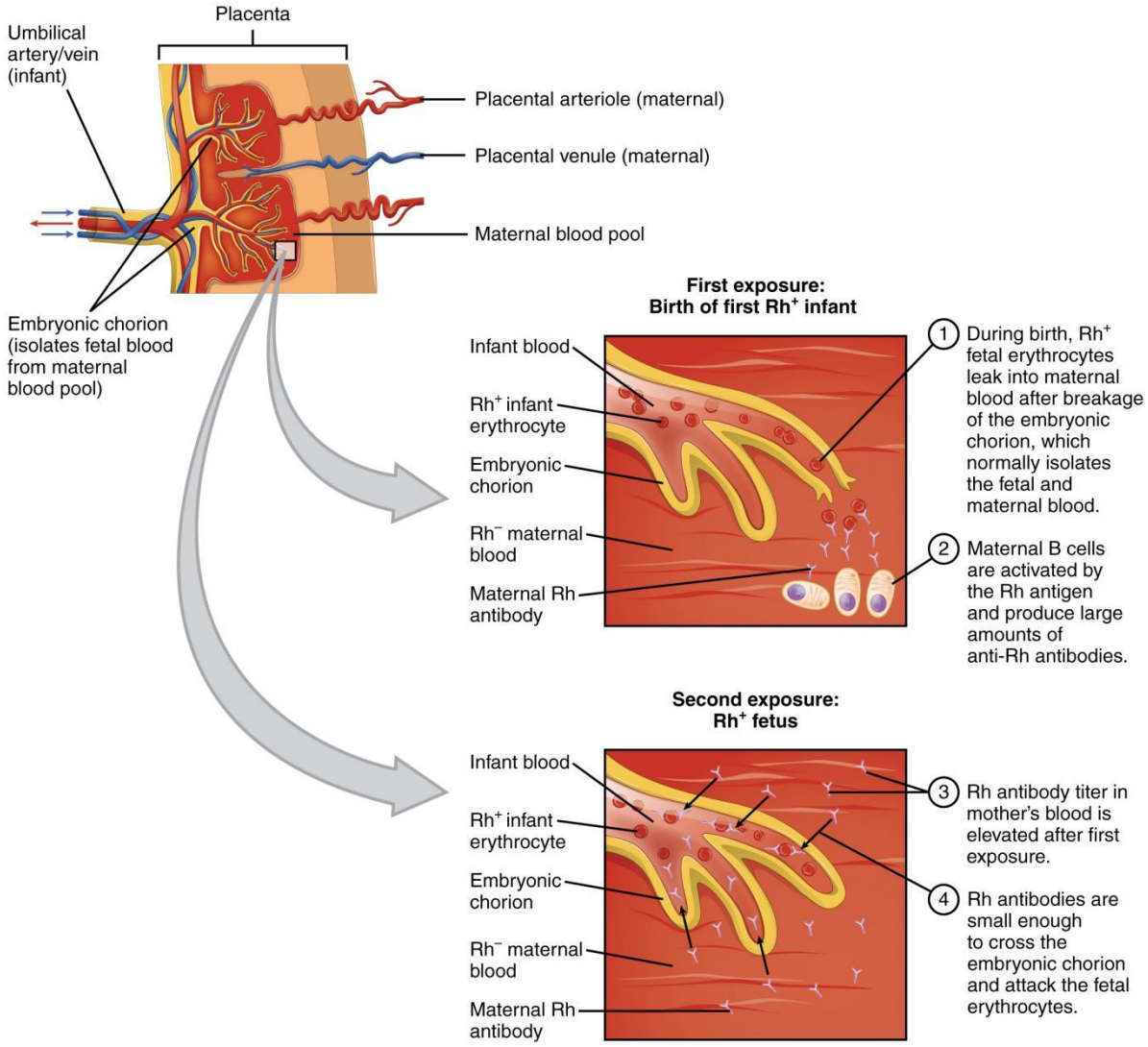

Figure 3.14 Erythroblastosis Fetalis. The first exposure of an Rh− mother to Rh+ erythrocytes during pregnancy induces sensitization. Anti-Rh antibodies begin to circulate in the mother's bloodstream. A second exposure occurs with a subsequent pregnancy with an Rh+ fetus in the uterus. Maternal anti-Rh antibodies may cross the placenta and enter the fetal bloodstream, causing agglutination and hemolysis of fetal erythrocytes. From Betts, et al., 2013. Licensed under CC BY 4.0. [Image description.]

Blood Transfusions

Figure 13.15 is an example of a commercially produced "bedside" card which enables quick typing of both a recipient's and donor's blood before transfusion. The card contains three reaction sites or wells. One is coated with an anti-A antibody, one with an anti-B antibody, and one with an anti-D antibody (tests for the presence of Rh factor D). Mixing a drop of blood and saline into each well enables the blood to interact with a preparation of type-specific antibodies, also called anti-seras.

Agglutination of RBCs in a given site indicates a positive identification of the blood antigens, in this case A and Rh antigens for blood type A+. To avoid serious and potentially fatal immune reactions, the donor's and recipient's blood types must match

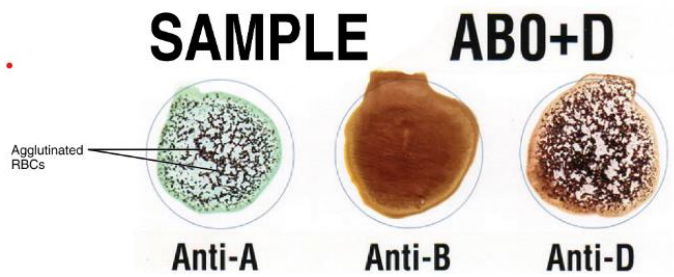

Figure 3.15. *Cross Matching Blood Types. From Betts, et al., 2013. Licensed under CC BY 4.0.*

To avoid transfusion reactions, it is best to transfuse only matching blood types; that is, a type B+ recipient should ideally receive blood only from a type B+ donor and so on. That said, in emergency situations, when acute hemorrhage threatens the patient's life, there may not be time for cross matching to identify blood type. In these cases, blood from a **universal donor** may be transfused.