BLOOD TRANSFUSION

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Basis of Blood grouping or Typing

- At least 30 commonly occurring antigens have been found on the cell membrane of RBCs.

These can cause Ag-Ab (antigen-antibody) reaction if mixed With plasma that contain Ab against these Ag.

- According to presence or absence of these antigens blood is classified into several groups , Two groups of Ag can cause transfusion reactions :
- ABO and Rh systems of Ag.

- Agglutinogens - glycoproteins on the surface of blood cells causes "agglutination" (clumping)
- ABO Blood Groups - determined by presence or absence of Type A and Type B agglutinogen proteins on the surface of RBCs cell membrane.
- Agglutinins - antibodies against either A or B agglutinogen , when bind agglutinins to RBC antigens, resulting in agglutination (clumping) or hemolysis (rupture) of RBCs

O-A-B Blood Types

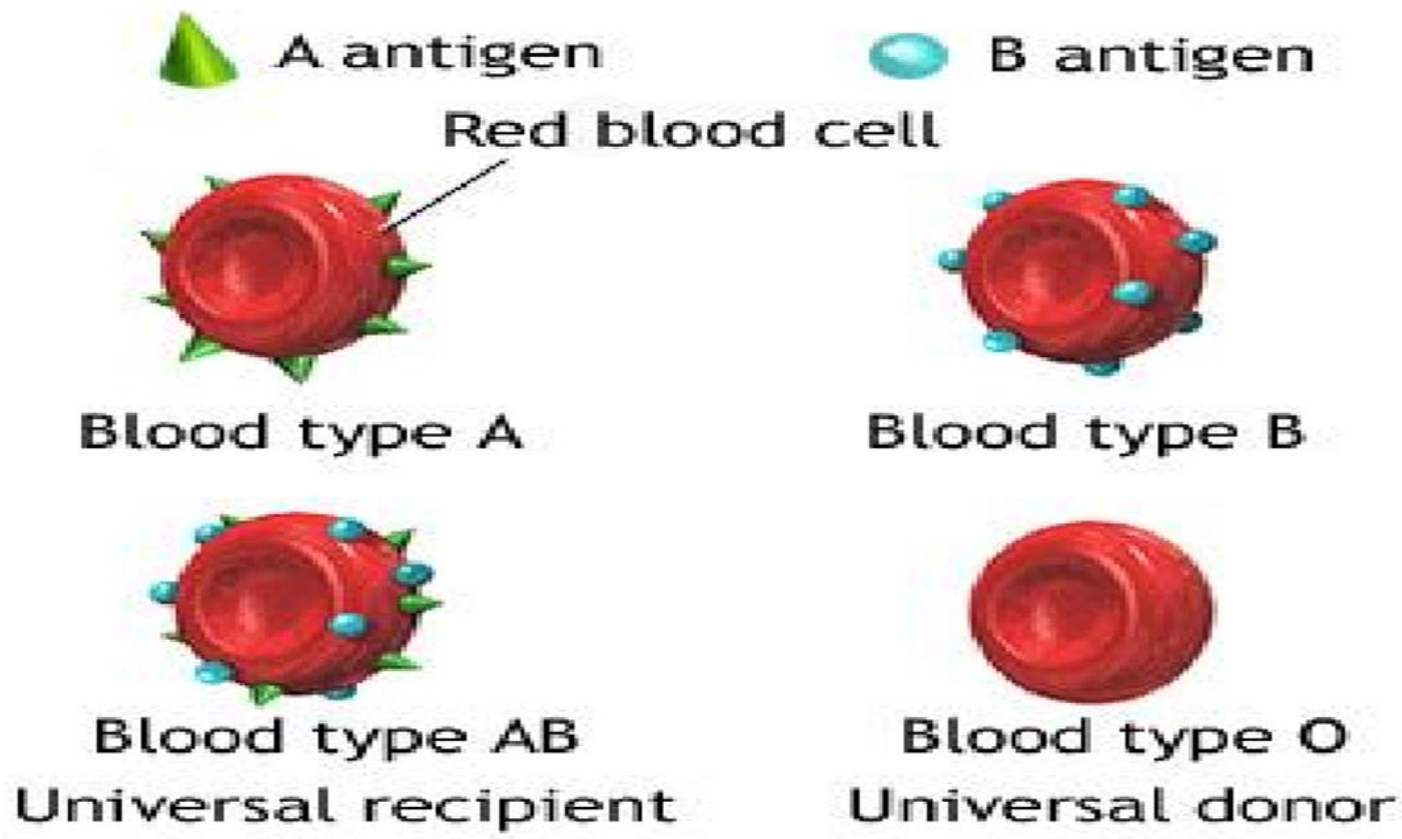
- **A and B Antigens—Agglutinogens**
- Two antigens—type A and type B—occur on the surfaces of the red blood cells in a large proportion of human beings. also called agglutinogens because they often cause blood cell agglutination.
- Major O-A-B Blood Types. the blood is normally classified into four major O-A-B blood types, depending on the presence or absence of the two agglutinogens, the A and B agglutinogens.

- When neither A or 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.

- **Agglutinins (antibodies)**
- 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.
- type O blood, contain no agglutinogens, so they contain both *anti-A* and *anti-B agglutinins;*
- type A blood contains type A agglutinogens and *anti-B agglutinins;* type B blood contains type B agglutinogens and anti-A agglutinins. Finally, type AB blood contains both A and B agglutinogens but no agglutinins.

- Titer of the Agglutinins at Different Ages. Immediately after birth, the quantity of agglutinins in the plasma is almost zero. Two to 8 months after birth, an infant begins to produce agglutinins
- Origin of Agglutinins in the Plasma.
- The agglutinins are gamma globulins, as are almost all antibodies, and they are produced by the same bone marrow and lymph gland cells that produce antibodies to any other antigens. Most of them are IgM and IgG immunoglobulin molecules. O 47% / A 41% / B 9% / AB 3%

ABO system for Blood Typing



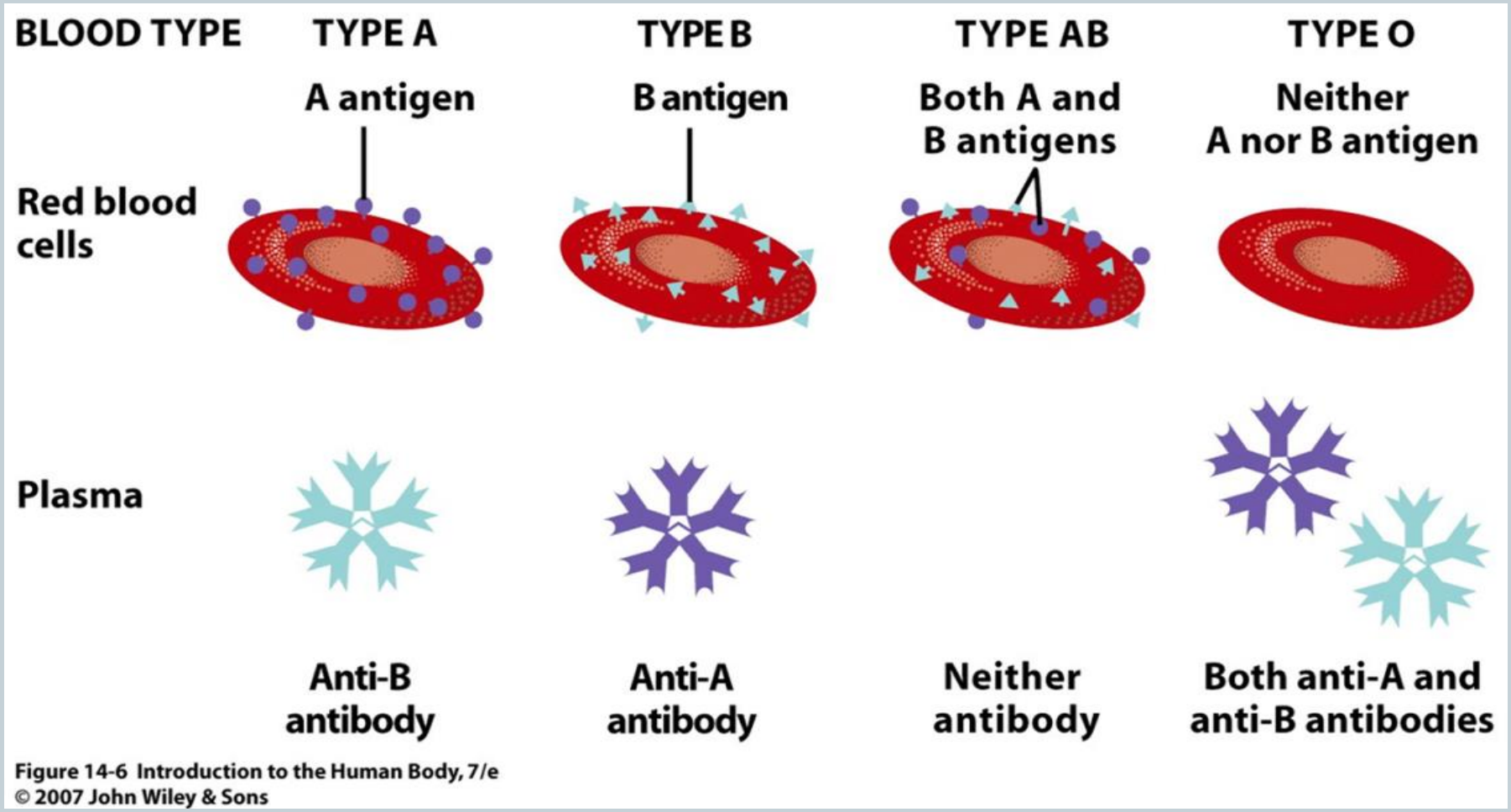


Figure 14-6 Introduction to the Human Body, 7/e

Blood transfusion:

- 1. A person with blood type A can receive blood from a donor with blood type A. The anti-B antibodies in the recipient do not combine with the type A antigens on the red blood cells of the donor.

- 2. A person with blood type B cannot receive blood from a donor with blood type A. The anti-A antibodies in the recipient will combine with the type B antigens on the red blood cells of the donor.

- 3. If the wrong blood type is used, the person's own immune system immediately attacks the donor's blood and causes clumps and RBC destruction (hemolysis) that can lead to total kidney failure and death.

Blood type	Agglutinogen on RBC	Agglutinin in plasma
A	A	Anti-B
B	B	Anti-A
AB	A and B	None
O	None	Anti-A and Anti-B

Transfusion reaction

- Plasma antibody meets its specific surface antigen , Blood will agglutinate and hemolysis , If donor and recipient blood types not compatible.
- Type AB has no AB antibodies so can receive any ABO type blood called Universal recipients.
- Type O have neither antigen so can donate to any other ABO type called Universal donors.

- Transfusion Reactions resulting from mismatched bloo d types lead to :
- 1.Agglutination and delayed hemolysis of donor's RBC (or immediate intravascular hemolysis)→

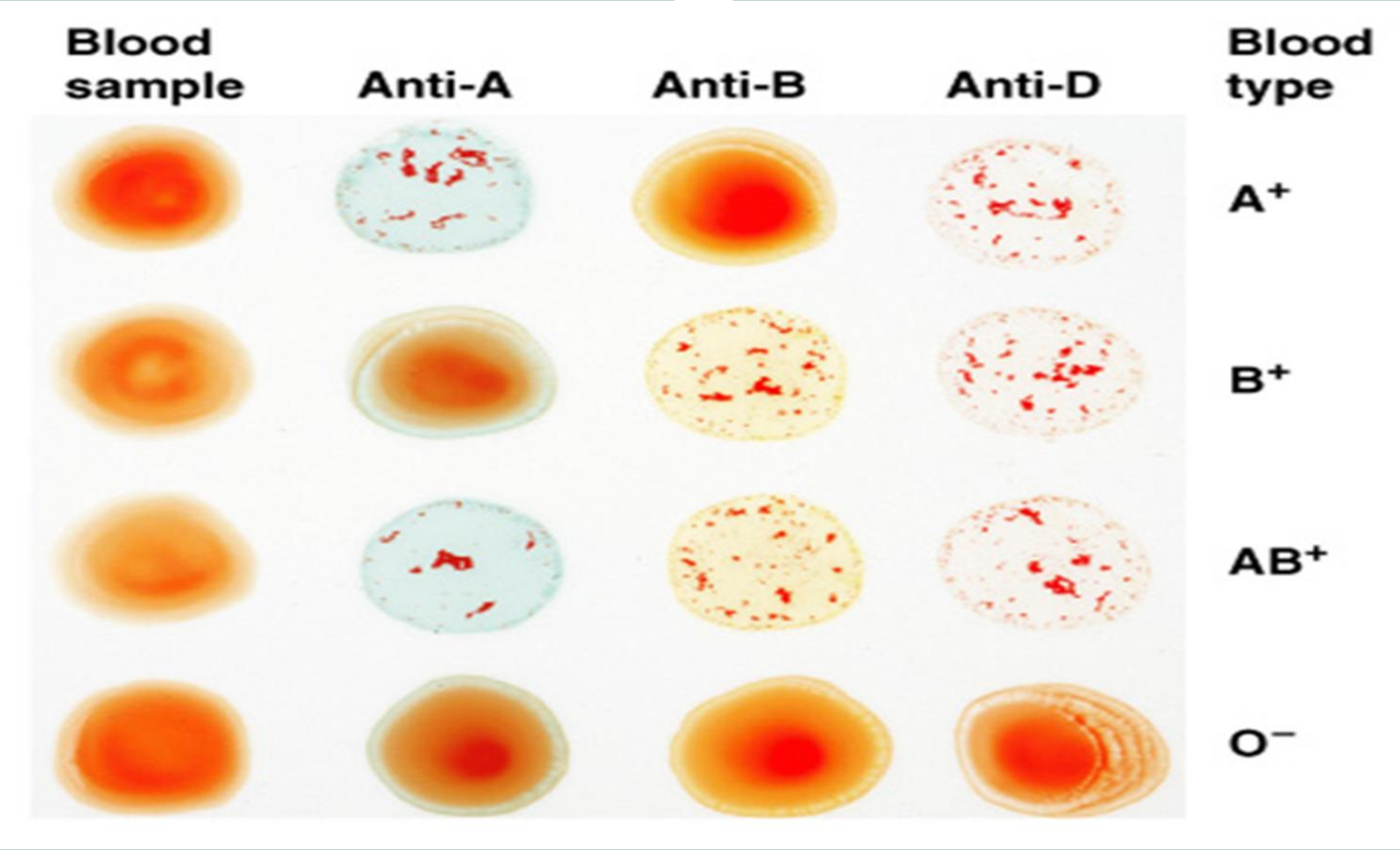
  Jaundice
- 2.Renal failure: Renal tubular blockage by hemoglobin

Rh System for Blood Typing

- The term "Rh-positive" means that the individual has agglutinogen D. The "Rh-negative" individual has no D antigen and forms the anti-D agglutinin when injected with D-positive cells.
- 85% of Caucasians are D-positive and 15% are D-negative; over 99% of Asians are D-positive.

Differences between ABO and Rh Ab?

- *Anti-D (Rh)antibodies do not develop naturally without exposure of a D-negative individual to D-positive red cells by blood transfusion or entrance of fetal blood into the maternal circulation ,
  Rh negative women pregnant with Rh +ve baby.


Blood sample
Anti-A
Anti-B
Anti-D
Blood type
A+
B+
AB+
O−

Hemolytic Disease of the Newborn (HDN)

- Is most common problem with "Rh incompatibility" arises when an Rh-negative mother carries an Rh-positive fetus.
- Small amounts of fetal blood leak into the maternal circulation at the time of delivery, and some mothers develop significant titers of anti-Rh agglutinins during the postpartum period. During the next pregnancy, the mother's agglutinins(Abs) cross the placenta to the fetus , cause hemolysis and various forms of hemolytic disease of the newborn (erythroblastosis fetalis).

- If hemolysis in the fetus is severe, may die in utero or may develop anemia, severe jaundice, and edema (hydrops fetalis). Kernicterus, a neurologic syndrome in which unconjugated bilirubin is deposited in the basal ganglia
- Prevention by :
- * by administering a single dose of anti-Rh antibodies in the form of Rh immune globulin during the postpartum period, (anti-D) IG.
- *has reduced the overall incidence of hemolytic disease by more than 90%.

- Indicated Anti-D in :
- If a woman has Rh- and gives birth to a child, or if she has a miscarriage or abortion, she is given an injection of anti-Rh antibodies called anti-Rh gamma globulin or RhoGAM to prevent HDN.
- Action of Anti-D:
- The antibodies bind to the fetal Rh antigens and inactivate them if they crossed the placenta during birth, and the mother's immune system does not respond by producing antibodies.

Agglutination Process In Transfusion Reactions

- When bloods are mismatched so that anti-A or anti-B plasma agglutinins are mixed with red blood cells that contain A or B agglutinogens, respectively, the red cells agglutinate as a result of the agglutinins' attaching themselves to the red blood cells.
- Because the agglutinins have two binding sites (IgG type) or 10 binding sites (IgM type), a single agglutinin can attach to two or more red blood cells at the same time. This causes the cells to clump, which is the process of "agglutination."

- Then these clumps plug small blood vessels throughout the circulatory system, either physical distortion of the cells or attack by phagocytic white blood cells destroys the membranes of the agglutinated cells,
- releasing hemoglobin into the plasma, which is called “hemolysis” of the red blood cells; During hours to days.

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.

Transfusion Reactions Resulting from Mismatched Blood Types

- all transfusion reactions eventually cause either immediate hemolysis resulting from hemolysins or delayed 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.

- Acute Kidney Shutdown After Transfusion Reactions.
- begins within a few minutes to few hours.
- Result from three causes:
- •First, the antigen-antibody reaction of the transfusion reaction releases toxic substances from the hemolyzing blood that cause powerful renal vasoconstriction.
- •Second, loss of circulating red cells and production of toxic substances from the hemolyzed cells and from the immune reaction, often causes circulatory shock.
- •Third, the hemoglobin precipitates and blocks many of the kidney tubules