

humans, most of the biliverdin is converted to bilirubin and excreted in the bile. The iron from the heme is reused for hemoglobin synthesis. Exposure of the skin to white light converts bilirubin to lumirubin, which has a shorter half-life than bilirubin. Phototherapy (exposure to light) is of value in treating infants with jaundice due to hemolysis. Iron is essential for hemoglobin synthesis; if blood is lost from the body and the iron deficiency is not corrected, iron deficiency anemia results .

## **BLOOD TYPES**

The membranes of human red cells contain a variety of blood group antigens, which are also called agglutinogens. The most important and best known of these are the A and B antigens, but there are many more.

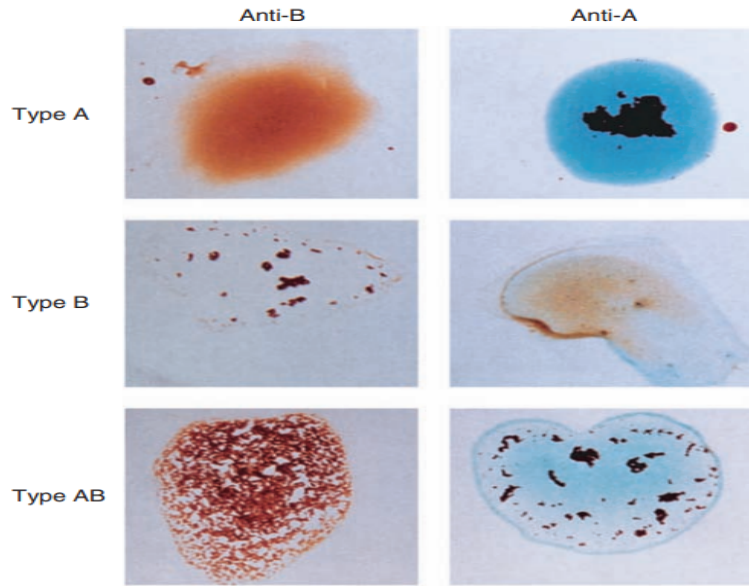
**THE ABO SYSTEM** The A and B antigens are inherited as mendelian dominants, and individuals are divided into four major blood types on this basis. Type A individuals have the A antigen, type B have the B, type AB have both, and type O have neither. The A and B antigens are complex oligosaccharides that differ in their terminal sugar. An H gene codes for a fucose transferase that adds a terminal fucose, forming the H antigen that is usually present in individuals of all blood types .Individuals who are type A also express a second transferase that catalyzes placement of a terminal N-acetylgalactosamine on the H antigen, whereas individuals who are type B express . a transferase that places a terminal galactose. Individuals who are type AB have both transferases. Individuals who are type O have neither, so the H antigen persists. Antibodies against red cell agglutinogens are called agglutinins. Antigens very similar to A and B are common in intestinal bacteria and possibly in foods to which newborn individuals are exposed. Therefore, infants rapidly develop antibodies against the antigens not present in their own cells. Thus, type A individuals develop anti-B antibodies, type B individuals develop anti-

A antibodies, type O individuals develop both, and type AB individuals develop neither (Table 31–3).

**TABLE 31–3 Summary of ABO system.**

<b>Blood Type</b>	<b>Agglutinins in Plasma</b>	<b>Frequency in United States %</b>	<b>Plasma Agglutinates Red Cells of Type:</b>
O	Anti-A, anti-B	45	A, B, AB
A	Anti-B	41	B, AB
B	Anti-A	10	A, AB
AB	None	4	None

When the plasma of a type A individual is mixed with type B red cells, the anti-B antibodies cause the type B red cells to clump (agglutinate), as shown in Figure 31–10. The other agglutination reactions produced by mismatched plasma and red cells are summarized in Table 31–3. ABO blood typing is performed by mixing an individual’s red blood cells with antisera containing the various agglutinins on a slide and seeing whether agglutination occurs.

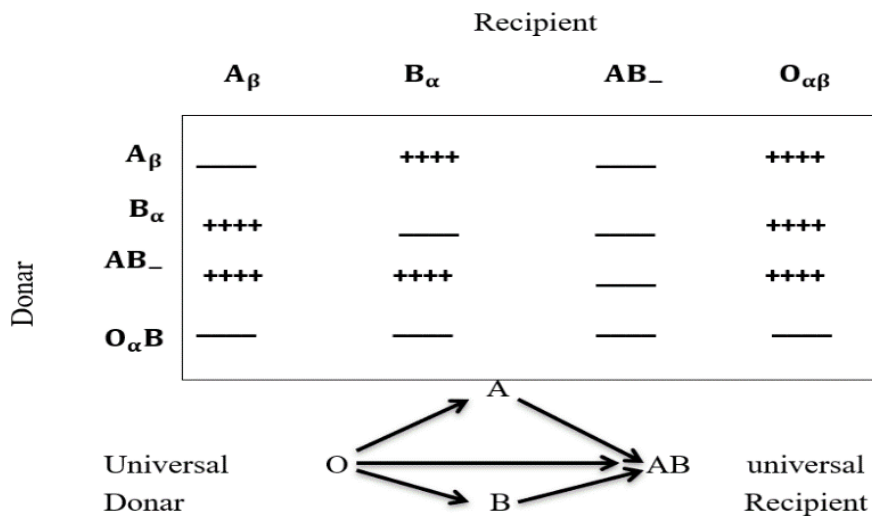


**FIGURE 31-10** Red cell agglutination in incompatible plasma.

## TRANSFUSION REACTIONS

Dangerous hemolytic transfusion reactions occur when blood is transfused into an individual with an incompatible blood type; that is, an individual who has agglutinins against the red cells in the transfusion. The plasma in the transfusion is usually so diluted in the recipient that it rarely causes agglutination even when the titer of agglutinins against the recipient's cells is high. However, when the recipient's plasma has agglutinins against the donor's red cells, the cells agglutinate and hemolyze. Free hemoglobin is liberated into the plasma. The severity of the resulting transfusion reaction may vary from an asymptomatic minor rise in the plasma bilirubin level to severe jaundice and renal tubular damage leading to anuria and death. Incompatibilities in the ABO blood group system are summarized in Table 31-3. Persons with type AB blood are "universal recipients" because they have no circulating agglutinins and can be given blood of any type without developing a transfusion reaction due to ABO incompatibility. Type O individuals are "universal donors" because they lack A and B antigens, and type O blood can be

given to anyone without producing a transfusion reaction due to ABO incompatibility. This does not mean, however, that blood should ever be transfused without being cross-matched except in the most extreme emergencies, since the possibility of reactions or sensitization due to incompatibilities in systems other than ABO systems always exists. In cross-matching, donor red cells are mixed with recipient plasma on a slide and checked for agglutination. It is advisable to check the action of the donor's plasma on the recipient cells in addition, even though, as noted above, this is rarely a source of trouble.



A procedure that has recently become popular is to withdraw the patient's own blood in advance of elective surgery and then infuse this blood back (autologous transfusion) if a transfusion is needed during the surgery. With iron treatment, 1000–1500 mL can be withdrawn over a 3-weeks period. The popularity of banking one's own blood is primarily due to fear of transmission of infectious diseases by heterologous transfusions, but of course another advantage is elimination of the risk of transfusion reactions.