Blood Types

from an article in the February 2002 Mathematics Teacher
by Vicki Young of Motlow State Community College

BACKGROUND

This lesson involves human blood types. Although types O, A, B, and AB were first identified around 1900, anthropologists theorize that type O has existed since the advent of Cro-Magnon man approximately 40,000years ago. Type A evolved from type O through a mutation in the red blood cells approximately 20,000 years ago. Type A red blood cells have an additional sugar molecule on the surface. A similar mutation caused the appearance of type B approximately 14,000 years ago. Type AB first appeared around 2,500 years ago. People with blood type AB have some red blood cells that include the A sugar molecule and some that have the B sugar molecule. The Rh factor, a protein found on the surface of some red blood cells, was discovered in 1940. Type O negative is called the universal donor because a transfusion introduces no additional A or B sugars or Rh protein into the recipient's bloodstream. Agglutination, or clumping, occurs when red blood cells of A, B, AB, or Rh positive blood are added to the bloodstream of a person whose red blood cells lack the protein or sugar. Researchers are seeking ways to remove the sugars and proteins from types A, B, AB, and O positive red blood cells to produce greater quantities of the universal donor.

A *compatible* blood type is one that introduces no new elements into the recipient's bloodstream. The compatible families, or all blood types that can safely donate blood to a given blood type, can be determined by examining the Venn diagram shown in figure 1. The universe for the diagram is O negative, since all blood is either O negative or O negative with added sugars or proteins. The three overlapping circles represent blood types with the A sugar, the B sugar, and the Rh protein. The diagram has eight regions, one for each blood type. Using figure 1 and the definition of compatible blood types, you should determine all compatible blood types for each of the eight types and shade them in the diagrams below (B^+ has been shaded for you in figure 2).

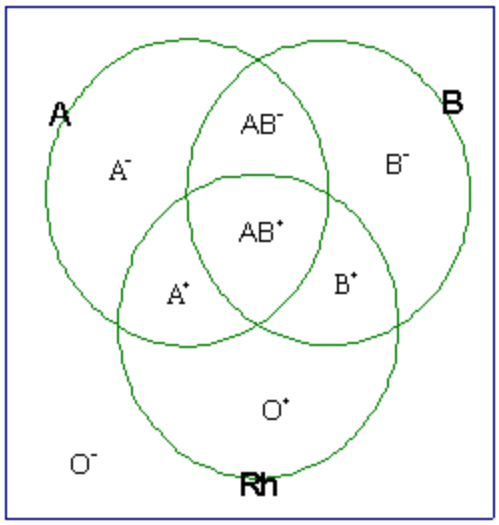


Figure 1

For example, my blood type is B^+ (the same as my philosophy of life!). The compatible blood types for B^+ are: B^+, B^-, O^+, and O^- because no new elements are introduced into the bloodstream.

Figure 2 shows the compatible blood types for B^+. You should fill in the other seven diagrams showing compatible blood types for A+, A-, B-, AB+, AB-, O+, and O-.

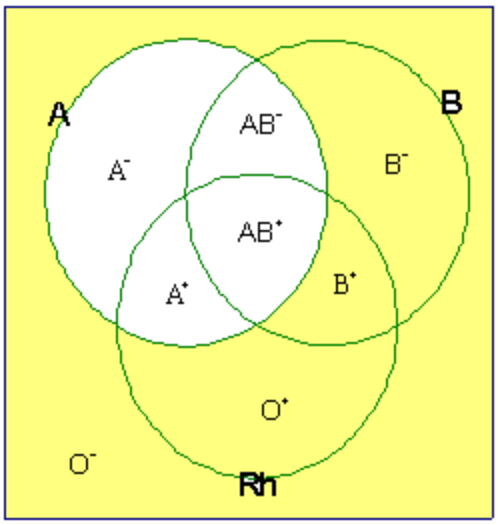
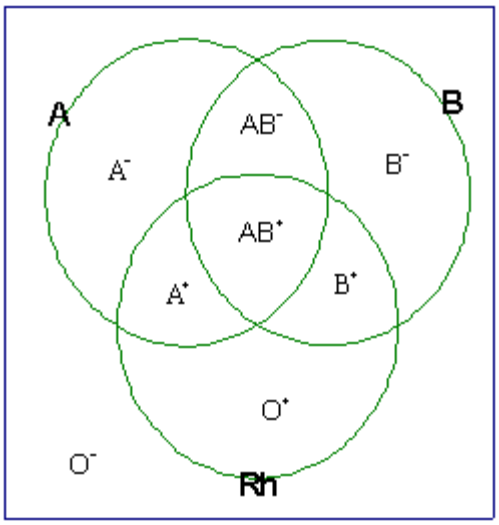
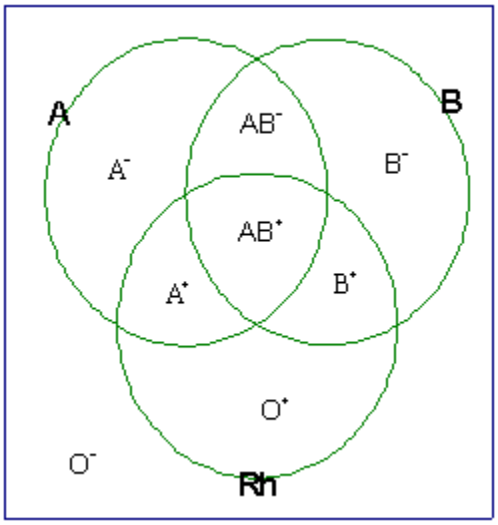


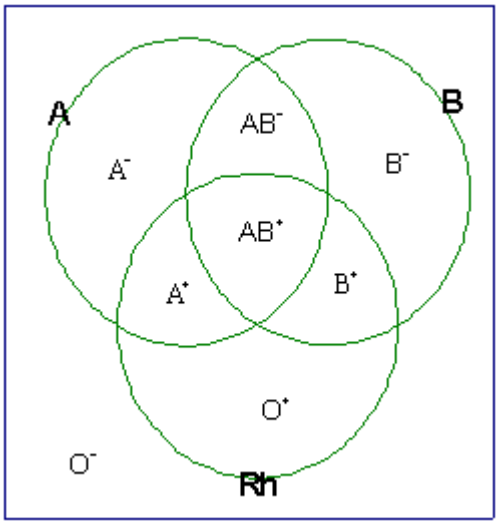
Figure 2 (Blood Types compatible with B^+)



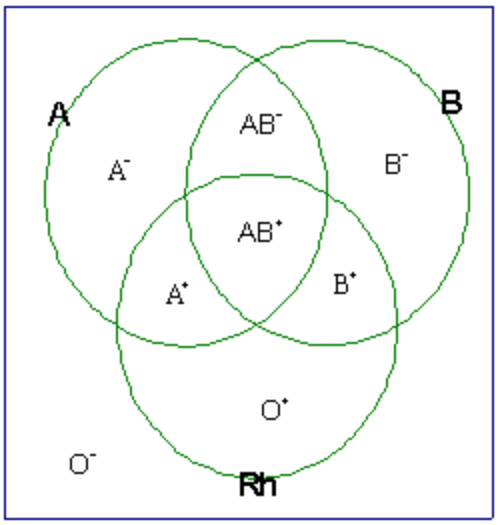
Blood Types compatible with B-



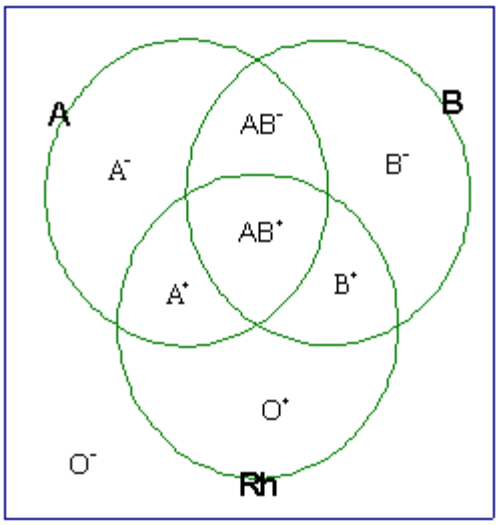
Blood Types compatible with O^-



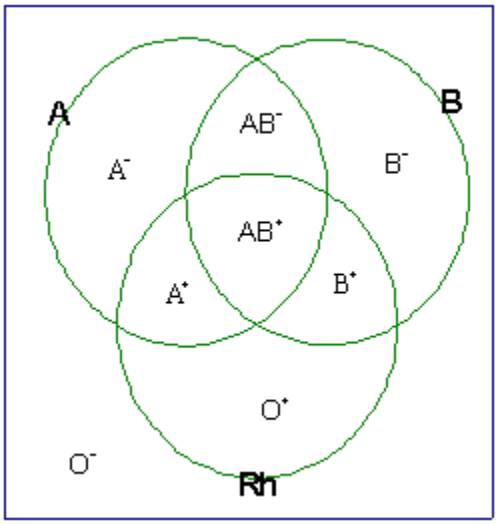
Blood Types compatible with O^+



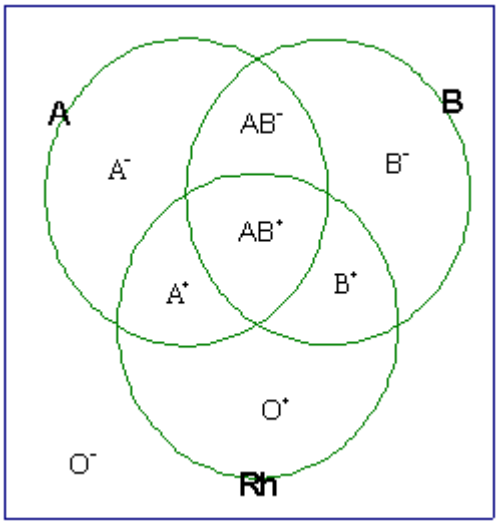
Blood Types compatible with A^-



Blood Types compatible with A^+



Blood Types compatible with AB^-



Blood Types compatible with AB^+

The following table shows the approximate blood-type percents for people living in the United States:

Blood Type	Percent
O^+	38%
O^-	8%
A^+	32%
A^-	7%
B^+	9%
B^-	2%
AB^+	3%
AB^-	1%

Now use the approximate blood-type percents, given in the table above, to determine the theoretical probabilities for each blood type. In other words, determine all the compatible blood types for a given type (that is, the blood types that the given type can safely receive). Then sum up the probabilities to determine what percent of the population could donate blood to a person with that type. Remember, you don't want to introduce any new sugars or proteins into that blood type.

Fill in the table below (B^+ has been done for you):

Blood Type	Compatible With	Theoretical Probability
O^+		
O^-		
A^+		
A^-		
B^+	**B^+, B^-, O^+, O^-**	.09 + .02 + .38 + .08 = .57
B^-		
AB^+		
AB^-		