Name _____ Per. _____ Date _____

ABO/Rh Simulated Blood Typing

Introduction

A blood transfusion with blood of a mismatched blood type usually has serious consequences for the recipient of the blood. Today, complete blood analysis is done with sophisticated, costly equipment before transfusions are done. The basic principles of blood typing will be illustrated in this activity using simulated ABO and Rh blood typing sera and simulated bloods.

Concepts

- Antigens
- Antibodies
- Multiple Alleles
- Codominance
- Rh factor

Background

General

Early attempts to transfer blood from one person to another produced varied results. Sometimes it seemed to help the recipient and other times it produced very serious consequences. Eventually, it was discovered that each individual has a unique combination of substances in his or her blood. Some of these substances may be compatible with another person's blood and some may not be compatible. These findings led to the discovery and development of procedures to type an individuals' blood. It is now known that safe transfusions of blood depend upon properly matching the blood types of the donors and the recipients.

Genetics of Blood Types

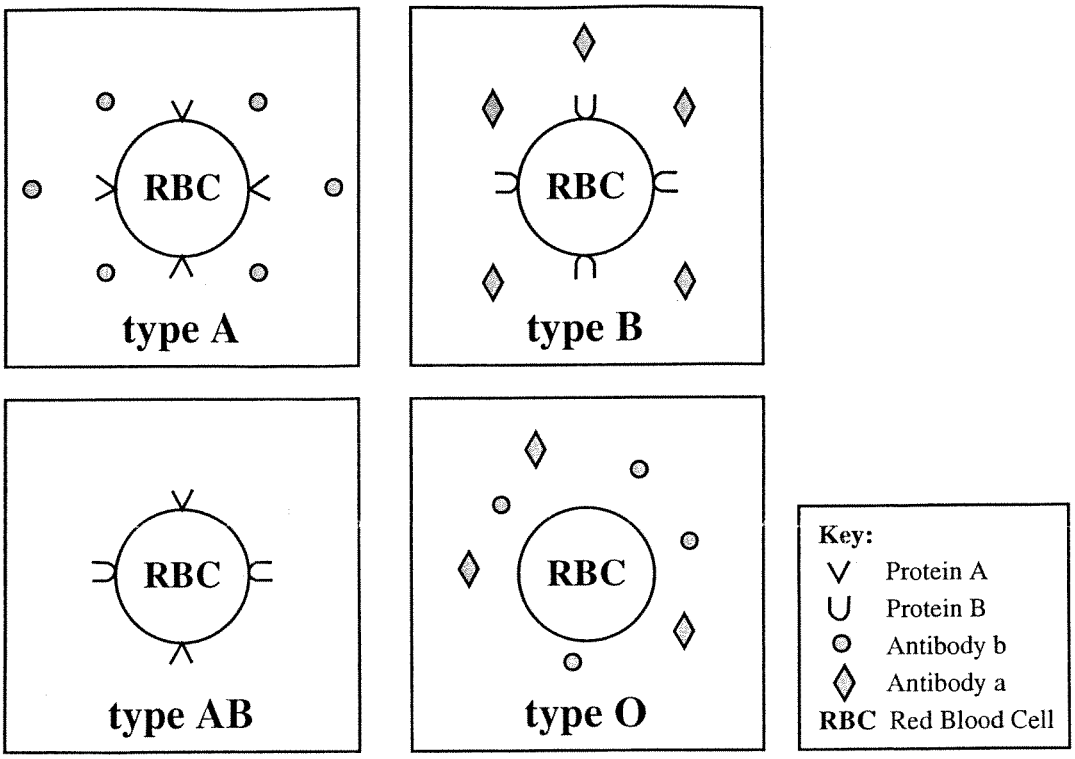
ABO blood type is determined by the presence or absence of specific proteins on an individual's red blood cells. A basic genetic principle is that an individual's inherited genes determines which proteins are produced in the individual's body. In the ABO blood typing system (just one of many blood factors) the blood proteins (antigens) are called the A and B proteins. The presence or absence of the A and B proteins on the red blood cells determines the individual's blood type in the ABO typing system. Individuals whose red blood cells contain protein A and lack protein B have type A blood. Those with protein B and lack protein A are called type B. Individuals with both protein A and protein B are called type AB and individuals with neither of the proteins is called type O.

ABO blood type is a genetic example of multiple alleles. There are three alleles in the gene pool for ABO blood type, i.e., I^A, I^B, and i. I^A codes for protein A, I^B codes for protein B and i codes for neither protein A nor protein B. Within this multiple allele pool the gene interactions illustrate both simple dominance as well as codominance. (Remember each individual has only two alleles for each trait even if there are multiple alleles in the gene pool.) When the I^Ai allele combination occurs, the individual is blood type A. When the I^AI^B combination occurs, the I^A and I^B alleles are codominant and the individual is blood type AB. The chart below illustrates the allele combinations, resulting blood type, proteins on the red blood cells, and antibodies in the blood for the four blood types in the ABO system.

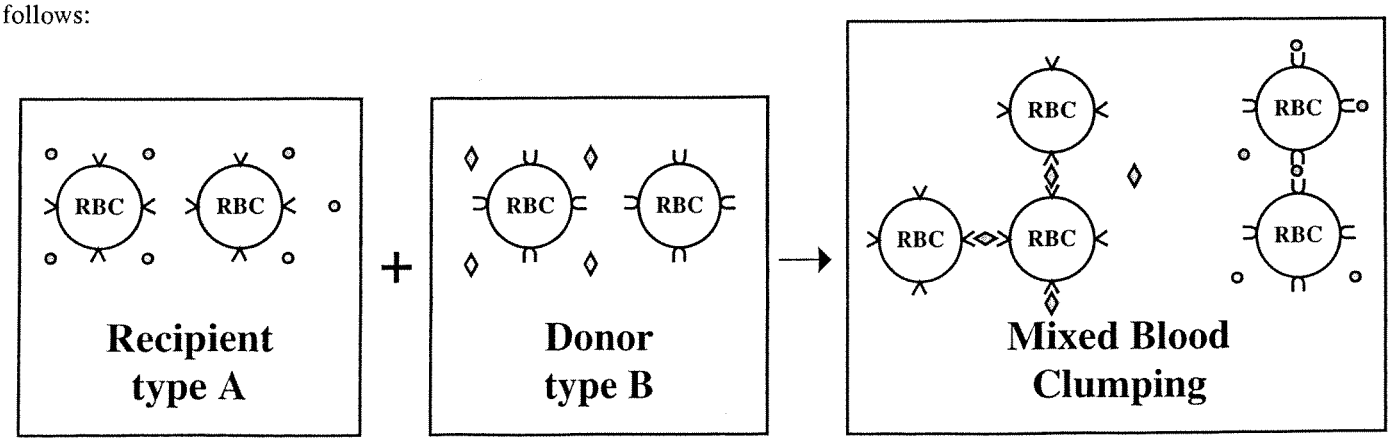
Phenotype	Genotype	Protein on RBC (antigen)	Antibodies in blood plasma
type A	I^AI^A or I^Ai	A	b
type B	I^BI^B or I^Bi	B	a
type AB	I^AI^B	A and B	—
type O	ii	—	a and b

Blood Transfusions

Blood groups are critically important with respect to transfusions. If someone with type A is given a transfusion of type B blood the two bloods will interact, clump and clog arteries which will have serious consequences to the individual. The clumping reaction is caused by the interaction of the proteins on the red blood cells and the antibodies present in the blood plasma. Antibodies are produced by the body in reaction to foreign proteins and are important in protecting the body against disease. Antibodies cannot distinguish a disease protein from protein on red blood cells. Individuals do not produce antibodies for proteins of their own red blood cells, but do produce antibodies for foreign proteins. Thus, a person with type A blood (A protein on surface of red blood cells) does not produce a antibodies. This person does produce b antibodies. If given the transfusion of type B blood, the antigens and antibodies of the mismatched blood will react and clump (a natural defense mechanism for foreign proteins). The illustrations below, in a very oversimplified way, illustrate the makeup of each of the four blood types.



Using the same illustration scheme, a transfusion of type B blood into an individual with type A blood might be illustrated as follows:



Similarly, a person with type B blood must not be given a transfusion with type A blood.

Because type AB blood lacks both a and b antibodies, it would appear that an AB person could receive a transfusion of blood from any other type. For this reason, type AB persons are sometimes call *universal recipients.* It should be noted, however, that type A (b), type B (a) and type O (a and b) blood still contain antibodies (either a or b) that could cause clumping of type AB cells. Consequently, even for AB individuals, it is always best to use donor blood of the exact same type as the recipient blood. If the matching type is not available and type A, B or O is used, it should be transfused very slowly so that the donor blood is well diluted by the recipient's larger blood volume.

Similarly, because type O blood lacks antigens A and B, it would seem that this blood type could be transfused into persons with blood of any other type. For this reason, persons with type O blood are often referred to as *universal donors.* Type O blood, however, does contain both anti-a and anti-b antibodies, and thus, if it is transfused into a person of a different blood type it should be done slowly to minimize large clumping reactions.

The bottom line for transfusion is that blood types should be matched for transfusions.

Blood Typing

ABO blood typing is based upon the clumping phenomena of bloods of mixed types. Blood sera antibodies can be isolated from other components of the blood and then used as blood typing sera. Antibodies-b (called Anti-a sera), for example, would clump red blood cells containing A-antigens (type A). Anti-b sera would clump type B blood. Clumping will occur in both sera with type AB blood and in neither sera with type O blood.

In the ABO blood typing procedure, drops of blood are first secured following sterile procedures. A drop of blood is placed in a drop of anti-a sera and another drop is placed in a drop of anti-b sera. The drops are then observed for clumping. The pattern of clumping or non-clumping is interpreted and the blood type determined. The following patterns occur for the various blood types:

Blood Type	Anti-a Sera	Anti-b Sera
A	clumping	no clumping
B	no clumping	clumping
AB	clumping	clumping
O	no clumping	no clumping

There are many other blood typing systems in addition to the ABO classification system. One commonly used system is the Rh factor.

The Rh blood group has several antigen factors on the surface of the red blood cells. If any of the antigens are present on the RBC surface, clumping can occur and the individual is said to be Rh positive (Rh^+). Conversely, if the red cells lack Rh antigens, the blood is said to be Rh negative (Rh^-).

Just like the ABO system the Rh factors are inherited. The genetics follow a simple dominant/recessive inheritance with Rh^+ being dominant. Unlike anti-a and anti-b, antibodies for Rh (anti-Rh) do not appear spontaneously. Instead, they form only in Rh-negative persons in response to special stimulation.

If an Rh-negative person receives a transfusion of Rh-positive blood, the recipients antibody producing cells are stimulated by the presence of the foreign Rh antigen and will begin producing anti-Rh antibodies. Generally, no serious consequences result from this initial transfusion. But if the Rh-negative person (who is now sensitized to Rh-positive blood—has antibodies) received another transfusion of Rh-positive blood at a later time, the donor's red cells are likely to clump.

A related condition may occur when an Rh^- woman is pregnant with an Rh^+ fetus for the first time. Such a pregnancy may be uneventful if the fetus' blood and mother's blood do not mix during birth. If, however, during birth or miscarriage, some of the infant's Rh^+ blood cells get into the mother's Rh^- blood, it might sensitize her blood and begin the production of anti-Rh antibodies.

If a mother who has already developed anti-Rh antibodies becomes pregnant with a second Rh^+ fetus, the anti-Rh antibodies can pass through the placental membranes and react with the Rh^+ fetal red cells, causing them to clump. The fetus often develops a condition knows as erythroblastosis fetalis which is likely to be very serious for the fetus.

ABO/Rh Simulated Blood Typing Worksheet

Using the ABO/Rh Simulated Blood Typing Handout, complete the following and answer the questions.

Part 1- Key Terms
Define the following Key Terms.

1 Antigens-

2 Antibodies-

3 Multiple Alleles-

4 Codominance-

5 Rh Factor-

Part 2- Questions
Answer the following questions.

General

1 Safe transfusions of blood depend upon properly matching what?

Genetics of Blood Types

1 ABO blood type is determined by the presences or absence of specific _____ on an individual's red blood cells.

2 What is another name for blood proteins? _____

3 What are the names of these blood proteins? _____

4 A person whose red blood cells contain the protein A and the protein B has the blood type _____.

5 A person whose red blood cells lack the protein A and the protein B has the blood type _____.

6 Explain why ABO blood type is an a genetic example of multiple alleles.

7 List the allele that codes for protein A. _____, protein B. _____, no protein. _____

8 A person with the genotype I I has the blood type _____.

9 A person with the phenotype blood type B has the genotype _____ or _____.

10 A person with the genotype I I has the blood type _____.

11 A person with b antibodies in their blood plasma has a the blood type _____.

12 A person with a and b antibodies in their blood plasma has the blood type _____.

13 A person with A and B antigens on their red blood cells has the blood type _____.

Blood Transfusions

1 What would happen if a person of one blood type received a transfusion of a different blood type?

2 Explain why the mixing of 2 different bloods will cause a clumping of the blood.

3 Explain why a person with the Blood Type O produces the a and b antibodies.

5 Why is blood Type AB called the "universal receiver?"

6 Why is blood Type O called the "universal donor?"

Blood Typing

1 Another name for Antibodies-b is called _____.

Another name for Antibodies-a is called _____.

2 List the steps of the ABO blood typing procedure.

a.

b.

c.

3 What would be the result of adding Anti-b Sera to Blood Type B? _____

4 What would be the result of adding Anti-b Sera to Blood Type O? _____

5 If a red blood cell has Rh antigens, the red blood cell is said to be _____. Conversely, if the red blood cell has no Rh antigens, the red blood cell is said to be _____.

6 Explain why an Rh- person does not have Anti-Rh sera in their blood plasma.

7 When does an Rh- person begin producing Anti-Rh Sera?

8 Explain the seriousness of having a mother with Rh- blood and a fetus with Rh+ blood.