NEO/SCI STUDENT'S GUIDE

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Linking Blood Donors and Recipients Using Neo/BLOOD™

WARNING — This set contains chemicals that may be harmful if misused. Read cautions on individual containers carefully. Not to be used by children except under adult supervision.

Objectives

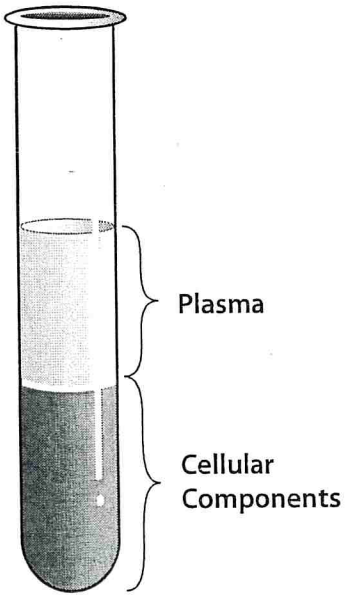
- ***Understand*** **the process of blood banking and donation**
- ***Perform*** **the ABO and Rh blood type tests using simulated blood samples from four potential donors and a recipient**
- ***Prepare*** **and** ***examine*** **a simulated blood smear under the microscope**
- ***Estimate*** **the number of simulated blood cells in a given area**

Background

Blood

Blood is a living tissue comprised of four components: plasma, red and white blood cells, and platelets. Plasma makes up 55% of the blood, while red and white blood cells and platelets make up the remaining 45% of the blood.

Blood makes up approximately 7% of a person's weight. An average-sized man has about 12 pints of blood, while an average-sized woman has about 9 pints. As soon as you donate or lose any blood due to an injury, the body automatically starts to make more. The fluid is immediately replaced, while the cells are replaced over a 6-week period.



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Blood functions principally as a vehicle which transports gases, metabolic waste products and hormones throughout the body. As blood passes through the lungs, oxygen molecules attach to the hemoglobin. As blood passes through the body's tissues in capillary beds, the hemoglobin releases the oxygen. Carbon dioxide and other waste gases are, in turn, transported by the hemoglobin back to the lungs. Thereafter, the process is repeated.

Blood Banking

Each year, about 12.6 million units of blood are donated in the United States by approximately eight million volunteer donors. This blood is transfused to about four million patients annually.

The donated blood can be used either as whole blood for one patient or be separated into its different components. One reason for separating blood into its components is patient compatibility. Human blood, unless it is one's very own, is by nature a foreign tissue and the body may attack it. By transfusing only the specific blood component the patient needs, the risk of rejection is minimized and the probability of success increases greatly. And because blood is separated into its components, as many as four patients can be served with a single pint of blood.

To separate the blood components, whole blood is spun in a centrifuge. The following components, are separated and used in different patients with various medical needs:

Red Blood Cells (RBCs)

Red blood cells or "erythrocytes" are round biconcave disks, without nuclei, that average about 7.5 microns in diameter. Each red blood cell contains the oxygen-binding protein hemoglobin. Hemoglobin contains four iron ions which bind with oxygen (O_2) and carbon dioxide (CO_2). Red blood cells transport oxygen and nutrients to the tissues and remove carbon dioxide and waste. The normal life span of RBCs in the circulation is only about 120 days. Worn out RBCs are removed by the spleen and liver, where hemoglobin is recycled.

Red blood cells are used for more than 70% of all transfusions in patients with ulcers, patients undergoing surgery and accident victims.

Table 1

Normal and Abnormal Red Blood Cell Counts

Red Blood Cells		
	MALE	FEMALE
Normal (at birth)	5.1 million cells per µl	4.5 million cells per µl
Normal (adult)	5.4 million cells per µl	4.8 million cells per µl
Anemia (low RBC count)	< 4.5 million cells per µl	< 4 million cells per µl
Erythrocytosis (high RBC count)	> 6.8 million cells per µl	>6 million cells per µl

White Blood Cells (WBCs)

Leukocytes, or white blood cells, are considerably larger than red blood cells, have nuclei, and are much less numerous; only one or two exist for every 1,000 red blood cells. This number increases in the presence of infection. There are three types of leukocytes: granulocytes, monocytes, and lymphocytes. All are involved in defending the body against foreign organisms. There are three types of granulocytes: neutrophils (the most abundant), eosinophils, and basophils.

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Platelets

Platelets (i.e. thrombocytes) are tiny bits of cytoplasm, much smaller than the red blood cells, which also lack nuclei. They are normally about 30 to 40 times more numerous than the white blood cells. They are produced as fragments of the cytoplasm of the giant cells of the bone marrow - the megakaryocytes. The platelets' primary function is to stop bleeding. When tissue is damaged, the platelets aggregate in clumps as part of the clotting process. Platelets, which are easily destroyed by radiation and chemotherapy, are used by cancer patients and by cardiovascular surgery patients.

Plasma

Plasma is a clear, straw-colored liquid and makes up 55% of the blood. It contains 92% water and is composed of a mixture of sugar, fat, proteins, various salts and a number of blood-clotting chemicals that help to stop bleeding. Plasma is used by burn patients, cardiovascular surgery patients and organ transplant recipients who require the fluid volume and the proteins, immunity factors, clotting factors and hormones contained in plasma. Fresh frozen plasma is given to patients who have hemophilia and other bleeding problems. Gamma globulin is used to supplement the immune system in fighting diseases such as hepatitis. Serum albumin is given to treat and prevent shock.

Several screening tests are performed on all donated blood to ensure that the blood is not infected with hepatitis viruses B and C, human immunodeficiency viruses (HIV) 1 and 2, human T-lymphotropic viruses (HTLV) I and II and syphilis, which can be transmitted through the blood. If any test result is positive, the unit of blood is discarded and the donor is notified of the results.

Blood is also typed A, B, O, or AB and positive or negative for the Rh factor. The blood type of a blood donor must be carefully matched to the recipient's blood type before any transfusion. For example, if a Type O patient receives A or B Blood Type or when a Type A patient receives Type B blood, the antigens on the surface of red blood cells trigger a severe immune reaction which can be fatal.

Rh incompatibility is less of a problem than ABO blood type incompatibility. An Rh-negative individual can tolerate an accidental transfusion of Rh-positive blood, because the reaction is not immediate. It takes 3-4 months for an Rh-individual to develop anti-Rh antibodies after a transfusion of Rh+ blood. At that time, if they are transfused a second time with Rh-positive blood, they may develop a transfusion reaction, during which agglutination may occur. For this reason, usually Rh compatibility is also tested when a patient's ABO blood type is determined.

To eliminate any possibility that a patient may be transfused with the wrong blood type, some hospital emergency rooms only stock Type O blood, which is known as the universal blood donor. However, this practice creates a shortage of Type O blood.

Based upon the universal blood donor concept, there is currently research taking place to develop a process that would make a common blood which can be given to people without the need for blood typing. This process would convert all donated blood types to Type O by the use of a special enzyme that modifies the surface of the red blood cells making them undetectable to the immune system. A readily accessible universal blood type would eliminate the need for blood typing in emergency rooms and would eliminate potential mishaps with patients receiving the wrong blood type.

Another key area of research that is currently underway is the development of a totally synthetic blood substitute. However, to date researchers have not been capable of synthesizing molecules that would carry out all of the functions of red blood cells. Until this potential new technology becomes a reality, blood donation is still the key factor in maintaining sufficient blood supplies.

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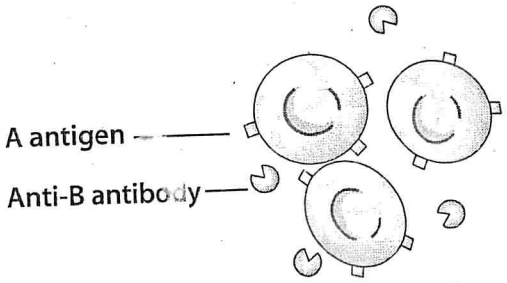
ABO and Rh Blood Typing

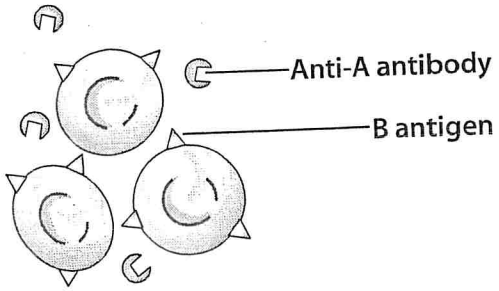
The first successful human blood transfusion, was performed by James Blundel in 1818. However, it was not until 1900 that Dr. Karl Landsteiner, an Austrian physician, observed that when blood from one person is mixed with the blood of another often the red blood cells agglutinate or clump together. This observation led Dr. Landsteinert to establish a blood typing procedure to distinguish the four) blood groups.

Surface proteins on red blood cells called "antigens" determine an individual's blood type. For example, an individual with A antigens has Blood Type A, one with B antigens has Blood Type B, one with both A and B antigens has Blood Type AB, and one with no antigens on the surface of his/her red blood cells has Blood Type O.

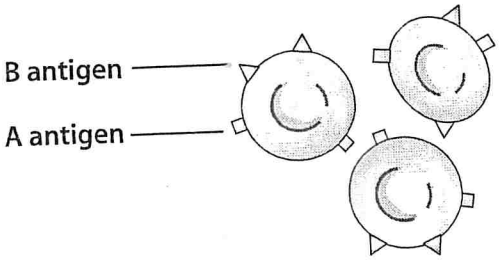
Blood plasma has circulatin proteins called "antibodies". For example, individua ith A surface antigen have anti-B antibodies; thos th B surface antigen have anti-A antibodies. Thos ith both A and B surface antigens have no antibodies. lividuals with no surface antigens have both anti-A anc ti-B antibodies.



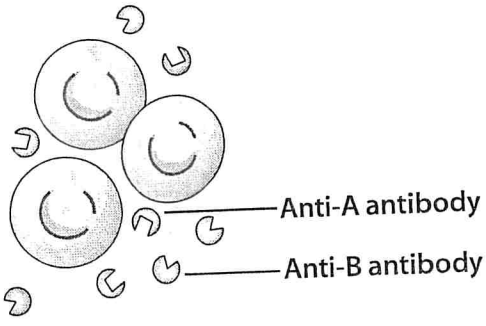
Blood Type A



Blood Type B



Blood Type AB



Blood Type O

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Table 2
ABO Blood Types Summary

Blood Type	Antigen on Red Blood Cells	Antibodies in Plasma	Can Recieve Blood From ...	Can Donate Blood To ...
A	A	B	O, A	A, AB
B	B	A	O, B	B, AB
AB	A and B	None	O, AB, A, B	AB
O	None	A and B	O	O, A, B, AB

Blood typing is performed using "antiserum" - blood that contains specific antibodies. "Anti-A Serum," which contains anti-A antibodies, and "Anti-B Serum," which contains anti-B antibodies, are used in ABO blood typing.

To perform a blood typing test, anti-A and anti-B sera are each separately mixed with the sample blood and observed for "agglutination" or clumping.

Table 3
Agglutination Reactions in the ABO System

ABO Agglutination Reaction		
Anti-A Serum	Anti-B Serum	Blood Type
Agglutination	No Agglutination	A
No agglutination	Agglutination	B
Agglutination	Agglutination	AB
No Agglutination	No Agglutination	O

Another important antigen on the surface of red blood cells is the Rh protein, named for the rhesus monkey in which it was first studied. People who have this protein are "Rh-positive," and those who lack it are "Rh-negative."

Table 4
Rh Agglutination Reactions

Rh Agglutination Reaction	Rh Factor
Agglutination	+
No agglutination	—

Table 5
Frequency of ABO Blood Types and Rh Factor in the U.S.

Blood Type	Frequency Percentage	Blood Type & Rh Factor	Frequency Percentage
A	42	A+	34
		A-	8
B	10	B+	8
		B-	2
AB	4	AB+	3
		AB-	1
O	44	O+	35
		O-	9