Biology Lesson: Finding a Match

A Simulated Blood-Typing Exercise

Concepts

- Blood type
- Genetics
- Antigens
- Antibodies
- Agglutination
- Donor/recipient matching prior to organ transplantation

Overview

Students use simulated blood samples to carry out a blood-typing activity to determine potential donors for a kidney patient in need of a transplant. Students then complete a laboratory report and answer questions related to blood typing and the genetics of blood type.

Instructional Objectives

Students will show an understanding of blood type and the genetics of blood type and the wider application of these concepts to organ transplantation by—

- determining blood types for nine different simulated blood specimens in the context of organ donation.
- examining the effects of mixing incompatible blood types and relating this to what happens during tissue rejection following a mismatched transplant.

Introduction

This lesson is a standard activity with a twist—blood typing taught in the context of organ transplantation. Before using this lesson, make sure that your students are familiar with the fundamentals of blood typing. (An optional conclusion question addressing genotype is provided.) Emphasizing the concept of blood as a tissue while learning about blood typing and transfusion can be used to clarify issues surrounding organ transplantation, rejection, and the use of immunosuppressive drugs. (See **Matching Donors with Recipients** and **Rejection.)**

Materials

For the Class:

Simulated Anti-A serum (blue)
Simulated Anti-B serum (yellow)
Nine simulated blood samples labeled as follows:

- Mr. Earle
- Child #1
- Child #2
- Child #3
- Child #4
- Child #5
- Child #6
- Child #7
- Child #8

For each of nine individual teams:

One of the simulated blood samples
1 glass microscope slide (or one 3-well blood-typing tray)
2 new (e.g. unused) toothpicks
Laboratory Report

For each student:

Student Packet

Black-line masters

Student Packet (4.5)
Laboratory Report (4.6)
Answer Key (4.7)
Master Chart (4.8)

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TIMING:
This activity should take your highest-level students only one 45-minute class period to complete. (However, they will probably need to complete their answers to Conclusion Questions for homework.)

Basic-level classes may need more guidance as they answer the Conclusion Questions. That may cause the activity to extend over two 45-minute periods.

NOTE: Please note that the information about Mike Earle and his family that appears in this blood-typing activity has been fabricated. Any similarity to persons dead or alive is unintended.

Preparation

1. It is recommended that you use a commercially prepared kit that contains simulated antiserum (anti-A and anti-B) as well as simulated blood types (A, B, AB and O).*

   Simulated blood-typing kits are available from almost all vendors that supply science materials and equipment to schools. The kits allow students to explore blood type related antigen/antibody reactions without any risk of exposure to blood-borne pathogens. Students follow the same procedures they would use to type actual blood with results that closely approximate typing real blood.

2. Pour the simulated blood into nine labeled test tubes or dropper bottles according to the following chart:

Label	Contents
Mr. Earle	Type A
Child #1	Type O
Child #2	Type O
Child #3	Type B
Child #4	Type A
Child #5	Type O
Child #6	Type AB
Child #7	Type B
Child #8	Type A

3. Make a copy of the Classroom Master Chart on your chalk or white board. Students will use this chart to enter their results after they determine the "blood type" of their sample. As an alternative, you might make a transparency of the black-line master provided and have students enter their results on your overhead projector.

* Although an online search for formulas to create your own simulated blood will result in several possible options, all of these formulas involve the use of materials that can be hazardous in the hands of students. (Hazards range from possible poisoning to skin rashes and burns).

NOTES:

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Procedure

NOTE: Remind students to use different and uncontaminated toothpicks to stir each blood sample.

1. Divide your class into nine teams. Distribute one of the labeled test tubes of "blood" that you have prepared to each team. (One team will receive Mr. Earle's "blood," while each of the other eight teams will receive the "blood" of one of Mr. Earle's children.)

2. Using the procedure steps outlined in the Student Packet, demonstrate the blood-typing procedure for the class. (Caution students against confusing a color change with agglutination.) Then direct each team to test their "blood" sample.

3. After students examine the "blood" drops for signs of clumping (agglutination) and determine the blood type of their sample, ask one member from each team to record the team's result on a Master Classroom Chart. (See step 3 of Preparation on page 70.)

4. Have each team copy the results from the master chart onto their copy of the laboratory report.

5. Have students answer the conclusion questions individually and attach their answers to the laboratory report for their team. (If your students have not yet studied heredity, you may want to have them skip question #1.)

6. If time permits, consider having the class discuss why clumping occurred in some samples and not in others.

Scoring Rubric

Although strong group participation is the goal, assessment is primarily based on individual responses to conclusion questions.

- Observations of student's conduct indicate full participation in the activity. The laboratory-report form is complete and accurate. All conclusion questions have been answered correctly. 3 points

- Observations of student's conduct indicate some participation in the activity. The laboratory-report form is complete. All conclusion questions have been answered. 2 points

- Observations of student's conduct indicate little participation in the activity. The laboratory-report form may be complete and/or accurate, but student did little more than observe the other members of the team carry out the procedures. Most conclusion questions have been answered. 1 point

- Observations of student's conduct indicate no participation in the activity. The laboratory-report form may be complete and/or accurate, but student did not participate in any way. Conclusion questions have not been answered. 0 points

Background

NASHVILLE — Country singer Mike Earle, battling kidney failure, is resting comfortably while doctors conduct tests to find a suitable transplant donor among his children, a spokesman said on Wednesday.

October 1, 2003

Country singer Mike Earle is "resting comfortably" while he waits for a kidney transplant.

Today, the hospital where you work has a famous patient. Country singer Mike Earle is suffering from kidney failure and you are a hematologist on duty. It will be your lab's responsibility to test blood samples from Mr. Earle and each of his eight children to determine whether or not there may be a suitable kidney donor among them.

Finding a kidney for transplantation is more than just finding a donor whose blood type matches the recipient's blood type. Kidney donors and recipients must also have histocompatibility (tissue compatibility) antigens that match. That's a complicated second step… your job, however, is only to determine the blood types.

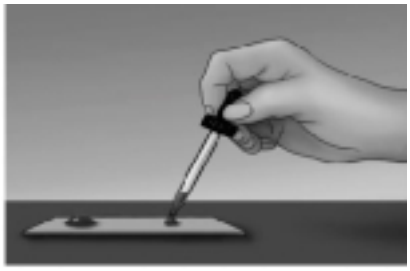
Four major blood types are found in humans: A, B, AB, and O. Another component associated with blood type is a protein called the Rh factor because it was first discovered in the **Rh**esus monkey. If this factor is present in a person's blood, the blood is said to be Rh positive (Rh+). Conversely, when this factor is absent, the blood is Rh negative (Rh–). This is why blood types are referred to as A+ or A–. While Rh factor is an important component to consider in matching donor and recipient for blood transfusions, Rh factor is not involved in matching donors and recipients in kidney transplantation. For purposes of this activity, it is assumed that all family members have the same Rh factor.

Student Objectives

- Use a blood-typing exercise as the first step in finding an organ suitable for transplantation.
- Observe the effects of mixing incompatible blood types during blood typing and relate these effects to those that occur during tissue rejection following a mismatched transplant.
- Use blood-type test results from some members of a family to determine the blood type of a non-tested member of the family.

Procedure

1. Your team has been assigned to identify the blood type of one member of the Earle family. Working with your team, place one drop of "blood" from your individual on each end of a clean microscope slide or in each of two wells of a blood-typing tray.



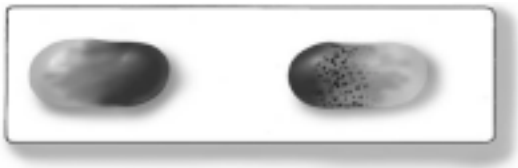
Place one drop of blood on each end of a clean slide.

2. Next, add one large drop of the Anti-A serum to one drop of blood and one large drop of Anti-B serum to the other drop of blood. Use one toothpick to mix the first drop of blood with the Anti-A serum and the other toothpick to mix the other drop of blood with the Anti-B serum. Why do you think it is necessary to use different toothpicks?

3. Look for clumping (agglutination) in each drop of blood. Clumping usually occurs within the first two minutes after adding the antiserum. (Do not confuse a color change with clumping.) If the donor/recipient has—

- type-A blood, clumping will only occur with the Anti-A serum.
- type-B blood, clumping will only occur with the Anti-B serum.
- type-AB blood, clumping will occur in both drops.
- type-O blood, there will be no reaction with either antiserum.

Blood with Anti-A serum



Blood with Anti-B serum

A positive test for type B blood

4. After you have determined the blood type for your sample, record it on the Classroom Master Chart your teacher has provided. Use the class's entries in this chart to complete a laboratory report for your team.

5. Complete the question sheet individually and attach your answers to your team's laboratory report.

Conclusion Questions

1. Based on the blood types for Mike Earle and his children, it is possible to determine the genotype for the blood group for each member of the Earle family. (Even though your class did not test Mrs. Earle's blood, you should be able to determine her blood type based on the blood types of Mr. Earle and the children.) Each member of your team should copy and complete Table 1.

Table 1. Blood Types

Label	Blood Type	Genotype
Mr. Earle		
Mrs. Earle		
Child #1		
Child #2		
Child #3		
Child #4		
Child #5		
Child #6		
Child #7		
Child #8		

2. Assuming that everyone in Mike Earle's family has the same Rh factor, then one family member can receive a blood transfusion from any family member. Which person can receive from anyone and why? (If your teacher told you to skip question #1, do not consider Mrs. Earle in your answers for this question and Question #3.)

3. Assuming that everyone in the family has the same Rh factor, more than one person can donate blood to all family members regardless of their blood type. Which family members can donate to everyone and why?

4. Mike Earle's high blood pressure has contributed to his kidney failure. Why is high blood pressure a common cause of kidney failure? Use an Internet search engine to answer this question and explain the connection here.

5. Explain why a kidney may be donated by a living individual with little risk to the donor.

6. Antibodies contained in antiserum cause the clumping of blood cells during the determination of blood type. Explain how this clumping compares to the body's rejection of a mismatched organ.

C. Bernard Kidney Transplantation Center

Hematology Laboratory

Preliminary Report

Date: _____ Technician(s) _____

Recipient *Mike Earle* Blood Type _____

Potential Donors

Donor	Blood Type
Child #1	
Child #2	
Child #3	
Child #4	
Child #5	
Child #6	
Child #7	
Child #8	

Possible Tissue Matches (List all donors whose blood type is the same as the recipient's.)

_____

_____

Additional Tests Recommended (Check all tests that should be completed on potential donors.)

☐ **Rh Factor** ☐ **Class I Histocompatibility Molecules** ☐ **Class II Histocompatibility Molecules**

Tissue Typing

The strongest antigens that can lead to transplant rejection are the Class I and Class II histocompatibility molecules. Genes for these antigens are encoded on chromosome 6. The collection of genes is called the major histocompatibility complex (MHC).

Testing for both Class I and Class II histocompatibility molecules is recommended as the next step.

1. The correct genotype chart:

Table 1. Blood Types

Label	Blood Type	Genotype
Mr. Earle	A	I^Ai
Mrs. Earle	B	I^Bi
Child #1	O	ii
Child #2	O	ii
Child #3	B	I^Bi
Child #4	A	I^Ai
Child #5	O	ii
Child #6	AB	I^AI^B
Child #7	B	I^Bi
Child #8	A	I^Ai

2. Child #6 can receive a blood transfusion from anyone because this person has neither Anti-A nor Anti-B antibodies.

3. Children #1, 2, and 5 can donate blood to all siblings and their parents regardless of their blood type because Type-O blood does not possess antigens for either A or B.

4. The heart of a person with high blood pressure works harder and, over time, blood vessels throughout the body are damaged. If the blood vessels in the kidneys are damaged, they may stop removing wastes and extra fluid from the body. The extra fluid in blood vessels may then raise blood pressure even higher. This becomes a dangerous cycle.

5. People only need one kidney to cleanse their blood. (Very strong evidence indicates that people without a predisposition to kidney disease—those with no diabetes, normal blood pressure, and normal kidney anatomy—have a very low likelihood of developing kidney failure after they donate a kidney.)

6. The clumping that occurs when blood is typed is caused when antibodies in the antiserum used to type the blood attack antigens on the surface of red blood cells causing the cells to clump together. This is similar to what happens when tissue rejection occurs. When organ donors and recipients do not match, antigens on the donor organ are attacked by antibodies produced by the recipient.

Master Chart

Recipient	Blood Type
Mr. Earle	
Donor	**Blood Type**
Child #1	
Child #2	
Child #3	
Child #4	
Child #5	
Child #6	
Child #7	
Child #8	