

Activity 5.3.2: Transfusion Confusion

Introduction

Jane Doe is in the hospital recovering from a car crash. She needs blood, but the blood bank is extremely low. Members of her family have offered to donate, but none of them know their blood type. Jane’s brother Tom, sister Mary, mother Harriett, and Grandpa Ed (her mom’s father) are local and are all willing to be tested. Jane’s other sister Sue is away at college, but she is going to have her blood tested at school and have the results sent to the hospital. Jane’s father, John and Grandmother Mona (her mom’s mother) have passed away. Their blood types remain unknown.

There are four types of human blood – type A, type B, type AB and type O. Only certain blood types are compatible with one another and can be safely transferred from person to person in a transfusion. In this activity, you will learn what controls blood type as well as what determines if your blood will “mix well” with that of another person’s. The body has an innate need to protect itself and if something foreign is introduced, it will attack.

Anything that is foreign to the body and gets your immune system fired up is referred to as an *antigen*. Antibodies are proteins in blood and lymph that seek out and bind to specific antigens. These specialized proteins are one of the primary defenders in your body’s army of immunity. Your body contains tons of antibodies, each designed to target and destroy a specific antigen. Our red blood cells have antigens on their surface that act to identify the type of cell. A person with blood type A has A antigens on his/her red blood cells. What antigens do you think you would find on the red blood cells of a person with B blood?

Someone who has the A antigen on his/her blood cells would not have Anti-A antibodies circulating in his/her plasma, the liquid portion of blood. If he/she did, the Anti-A antibodies would find and attack the red blood cells marked with the A antigen. When this happens, the blood agglutinates or clumps. A person with the A antigen does, however, have circulating anti-B antibodies. These antibodies do not attack the red blood cells with the A antigen. But what if you introduced B blood cells into the system? In the lab, you will use the rules of antigen/antibody interactions and the presence of visible clumping to determine blood type.

In this activity, you will type the simulated blood of your patient as well as the blood of her family members. You will analyze the results and use your knowledge of antigen/antibody interactions to determine who is a potential blood donor for Jane. Accurate blood typing is essential for safe blood transfusions. Using information from your blood typing tests, you will create a family pedigree for blood type and use information on this genetic family tree to determine the blood type of those you could not test. As you complete this task, you will learn about the interactions between antigens and antibodies, and you will review basic principles of genetics and inheritance.

Equipment

* Computer with Internet access
* WARD’S Simulated ABO and Rh Blood Typing Lab Activity kit
* Simulated blood samples (Jane, Mary, Tom, Harriett and Ed)
* Anti-A serum
* Anti-B serum
* Blood typing slides
* Mixing sticks
* Laboratory journal
* Safety goggles
* Pedigree Resource Sheet

Procedure

Part I: Blood Typing

1. Fill out the first two rows of the table (antigens and antibodies) as you participate in the class discussion.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **TYPE A** | **TYPE B** | **TYPE AB** | **TYPE O** |
| **Red Blood Cell Surface Antigen(s)** |  |  |  |  |
| **Plasma Antibodies** |  |  |  |  |
| **Can Receive Blood from…** |  |  |  |  |

1. Based on what you have learned about antigens and antibodies, work with your partner to fill in the remaining row of the table. Discuss what determines the type(s) of blood a person is able to receive.
2. Answer conclusion question 1.
3. Discuss the chart with the class.
4. Put your knowledge of antigen and antibody interactions to the test as you help Jane Doe find a blood donor. Work with a partner to test the blood of each family member and determine blood type.
5. Record your results in the following table.

|  |  |  |  |
| --- | --- | --- | --- |
| **Blood Sample** | **Agglutination in Well A (+/-)** | **Agglutination in Well B (+/-)** | **Blood Type** |
| Jane |  |  |  |
| Mary |  |  |  |
| Tom |  |  |  |
| Harriett |  |  |  |
| Ed |  |  |  |

1. Put on safety goggles.
2. Starting with Jane and working one sample at a time, place two drops of simulated blood in the A and the B wells of a clean blood typing slide.
3. Place two drops of Anti-A serum in the well labeled A.
4. Place two drops of Anti-B serum in the well labeled B.
5. Using a separate mixing stick for each well, mix the simulated blood and antiserum for approximately ten seconds.
6. Carefully examine each well to see if the blood has clumped. If agglutination has occurred, place a “+” in the appropriate box in the table. Remember that you will only see agglutination if a specific antibody meets up with its specific antigen. Record your observations and use the information to determine blood type.
7. Using a fresh tray for each sample, repeat steps 7-11 to determine the blood type of the other family members.
8. Using information from the lab, determine who is able to donate blood to Jane. Note that Sue just called in to let everyone know that she is blood type O. Refer back to your initial table of blood types to help you decide.
9. Answer conclusion questions 2 and 3.
10. Note that blood typing results also reveal that everyone in the family is Rh positive (Rh+). Research what this means in terms of antigens on the red blood cells. Describe your findings in your laboratory journal.

Part II: Genetics of Blood Type

Remember that our chromosomes carry two *alleles*, or forms of a gene that provide the code for each of our traits. We receive one allele from Mom and one allele from Dad. Most traits are only coded for by two alleles, one that is dominant and one that is recessive. Blood type, however, is controlled by three different alleles – the A allele (usually designated **IA**), the B allele (usually designated as **IB**) and the O allele (usually designated as **i**). Remember that *dominant* alleles are usually represented with a capital letter and *recessive* alleles with a lower case letter. The A and the B allele are both dominant so we call them *codominant*. Neither allele wins out over the other and is expressed alone. The O allele is recessive and gets masked by either of the two dominant alleles.

1. Note that *phenotypes*, traits we see, are controlled for by *genotypes*, the combination of alleles we inherit from our parents. You know that there are four different phenotypes for blood type (Type A, Type B, Type AB and Type O). Since each person has two alleles for each trait (one from Mom and one from Dad), what are the possible genotypes for each blood type? One of the genotypes for Blood Type A has been filled in for you. Note that this genotype is considered *homozygous*. There are two of the same alleles. Note: There may be more than one possible genotype for a given blood type.
* Blood Type A: **IAIA**
* Blood Type B:
* Blood Type AB:
* Blood Type O:
1. Review the possible genotypes with the class.
2. Remember that pedigrees are diagrams of family relationships that illustrate how a particular trait is passed from person to person. Review the structure of pedigrees using the Pedigree Resource Sheet. Note: You do not need to complete the associated check for understanding questions.
3. In your laboratory journal, draw a pedigree that shows the distribution of blood type in the Doe family. Remember that in a pedigree, men are represented by squares and women are represented as circles. Use the sites listed in Step 18 to find example pedigrees if you do not remember how they are structured.
4. Write the name of the individual underneath each square or circle in the pedigree, and write the blood type inside of the shape.
5. Work with your partner to analyze your pedigree and to determine blood type for John and Mona. You did not test their blood, but the pedigree will give you many clues. You may be able to narrow it down to just one blood type or you may find that there is more than one possibility. That is OK – take it as far as you can. Describe your findings in your laboratory journal.
6. When you have determined the blood types for John and Mona, show your answer to your teacher and explain your reasoning. If you are correct, add the blood types to your pedigree. If you are incorrect, use clues your teacher gives you to work out the correct solution.
7. Answer the remaining conclusion questions.

Conclusion

1. Explain why a person who has AB blood is considered the universal recipient. Why can this person receive any other blood type?
2. Explain why Jane can not receive blood from her sister Mary.
3. What happens when an antigen on a red blood cell comes in contact with the antibody designed to seek it out? Why would this be a bad thing?
4. Explain how you were able to determine John’s blood type. BONUS: What is John’s genotype?
5. Explain why blood is classified as a type of connective tissue.
6. Explain how blood type contributes to your identity.