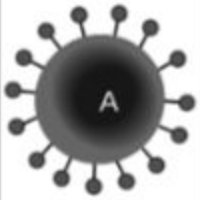
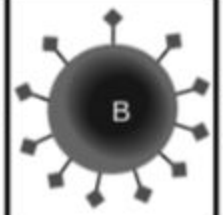
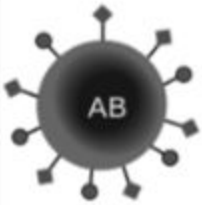
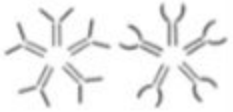
Lab 16: Inheritance of Blood Type: Are All of Mr. Johnson's Children His Biological Offspring?

Introduction

Karl Landsteiner identified the ABO blood group in 1901. The ABO blood group includes four types of blood (A, B, AB, and O). The differences in blood types are due to the presence or absence of certain types of antigens and antibodies. Antigens are molecules that are located on the surface of the red blood cells (RBCs), and antibodies are molecules that are located in the blood plasma. Individuals have different types and combinations of these molecules. The figure below shows which antigens and antibodies are associated with each blood type in the ABO blood group.

Blood types and red blood cell surface antigens

	Type A	Type B	Type AB	Type O
Red blood cell type				
Antibodies in Plasma	 Anti-B	 Anti-A	None	 Anti-A and Anti-B
Antigens in Red Blood Cell	 A antigen	 B antigen	 A and B antigens	None

A single gene that consists of three different versions (or alleles) determines the four blood types in the ABO group. Allele A codes for the synthesis of RBCs that have the type A antigens on their surface. Allele B codes for the synthesis of RBCs that have the type B antigens on their surface, and allele O codes for RBCs that lack surface antigens. The A and B alleles are codominant to each other, and both the A and B alleles are dominant over the O allele. Although there are three different alleles associated with the ABO blood group gene, each individual only inherits two copies of it. One copy of the gene comes from the mother and one copy of the gene comes from the father. The ABO blood type therefore follows the multiple allele model of inheritance.

Although blood type is an inherited trait, the U.S. judicial system does not recognize ABO blood typing as an acceptable way to determine paternity because many individuals can have the same blood type. In the United States, for example, approximately 44% of the population has type O blood, 42% has type A blood, 10% has type B blood, and 4% has type AB blood. ABO blood-typing, however, can be used to exclude a man from being a child's father. Therefore, it is sometimes useful to conduct a quick and inexpensive test for ABO blood type to determine if further testing using a DNA analysis is warranted.

Your Task
Mr. and Mrs. Johnson have been married for eight years. During this time, Mrs. Johnson has had three children. Recently Mr. Johnson found out that Mrs. Johnson has been secretly dating another man, Mr. Wilson, throughout their marriage. Mr. Johnson now questions if he is truly the biological father of the three children. Your goal is to use what you know about the inheritance of ABO blood types to determine if Mr. Johnson can be excluded as the father of any of Mrs. Johnson's children.

The guiding question of this investigation is: ***Are all of Mr. Johnson's children his biological offspring?***

Materials
You may use any of the following materials during your investigation:

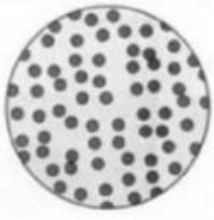
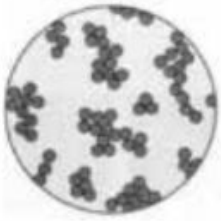
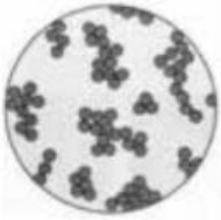
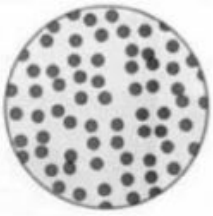
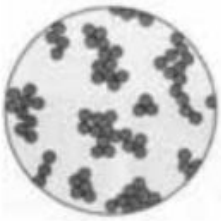
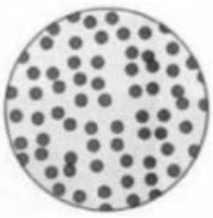
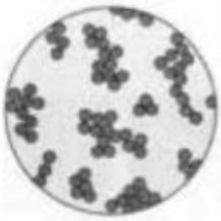
- Type A blood sample
- Type B blood sample
- Type AB blood sample
- Type O blood sample
- Blood sample from Mr. Wilson
- Blood sample from Mr. Johnson
- Blood sample from Mrs. Johnson
- Blood sample from child 1
- Blood sample from child 2
- Blood sample from child 3
- Anti-A serum
- Anti-B serum
- 6 blood-typing slides
- Toothpicks

Getting Started
To test a person's blood type, you can mix a sample of blood with an antiserum that has high levels of anti-A or anti-B antibodies. The simple test is performed as follows:

1. Add two drops of a blood sample to well A and to well B of a blood-typing slide.
2. Add two drops of the appropriate antiserum to each of the samples.
3. Stir each sample for 20 seconds with a toothpick.

If the blood cells have the appropriate antigens on their surface, agglutination (clumping of the blood) will occur. For example, if anti-A serum is added to a sample of blood and agglutination occurs, that means the blood contains cells that have the type A antigens on their surface. The figure below illustrates the reaction of each antiserum with each blood type. Be sure to test known samples first before the unknown samples to see what the agglutination reactions look like.

Reaction of different blood types with antiserum

Antiserum	Reaction when blood is mixed with antiserum			
	Type A	Type B	Type AB	Type O
Anti-B				
Anti-A				

Report

Once you have completed your research, you will need to prepare an investigation report that consists of four sections (be sure to have section headings):

1. Introduction: Give some background information on the topic. Explain what question you were trying to answer and include a hypothesis. (Background info, research question and hypothesis)
2. Procedure: What did you do during your investigation and why did you conduct your investigation in this way? (How you collected and analyzed data)
3. Data: Include a data table and/or graph to show your results. Be sure to include a title for your table or graph with labels for the variables.
4. Conclusion: What is your argument? (Claim - Evidence - Reasoning)

Your report should answer these questions in two pages or less. The report must be typed, and any diagrams, figures, or tables should be embedded into the document. Type your report on Google Docs (12 point font, double-spaced) and share it with your teacher. Your report will be graded based on the rubric in the class syllabus.