Why Opposites Attract: Agglutination

Student Activity 3B

Activity Introduction:

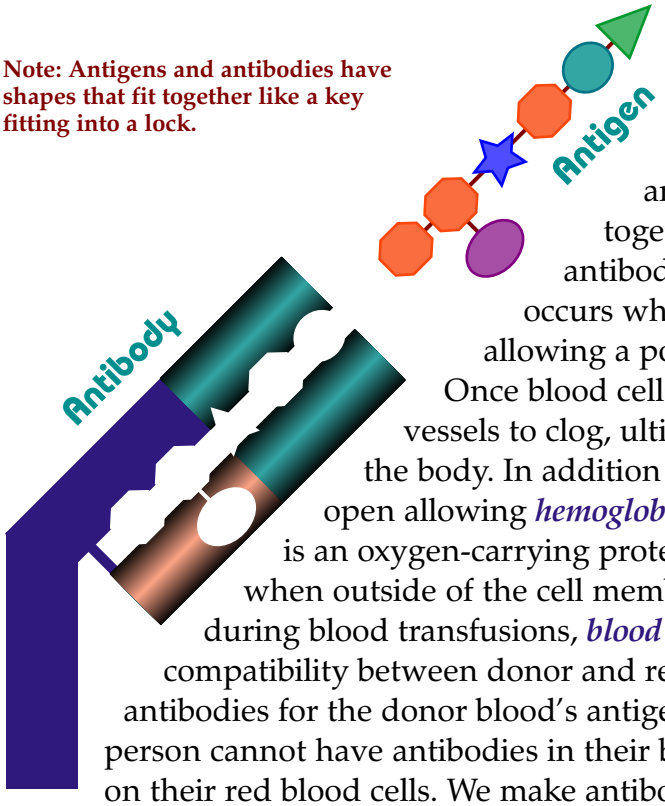
Have you ever heard the phrase "Opposites Attract"? Well, for certain blood antigens and antibodies it's true. This reaction was first discovered by Karl Landsteiner, shortly after he identified the ABO blood groups in 1901. Landsteiner found that humans possess ***immunity*** to blood antigens differing from their own type. This immunity is caused by the presence of antibodies in the bloodstream.

Activity Background:

Antibodies are protein molecules that are triggered the presence of by ***antigens***. Antigens are molecules recognized by the immune system as foreign to the body causing an immune response. Antibodies to ABO antigens are produced when we are babies in response to environmental factors such as bacteria and fungi. It is important to note that we only make antibodies to the ABO antigens we **do not possess** on our red blood cells. Antibodies are found in the ***plasma*** of our blood rather than on red blood cells. Antibodies have very specific ***shapes*** and must be designed to fit antigens exactly. The best way to think of an antigen/ antibody pair is to imagine two jigsaw puzzle pieces fitting together or a key fitting into its lock, see ***Figure 1 Antigens and Antibodies***.

Figure 1
Antigens and Antibodies

Note: Antigens and antibodies have shapes that fit together like a key fitting into a lock.



Once an antibody recognizes its ABO antigen, it will bind to the antigen, bringing any attached red blood cell with it. When many antigens bind to the antibody, the attached red blood cells clump together. This clumping of red blood cells by antibodies is known as ***agglutination***. Agglutination occurs when incompatible blood types are mixed, allowing a potentially fatal ***antibody – antigen reaction***. Once blood cells have agglutinated, they can cause blood vessels to clog, ultimately ceasing circulation to various parts of the body. In addition to this clotting, agglutinated cells can split open allowing ***hemoglobin***, to be released into the body. Hemoglobin is an oxygen-carrying protein in the red blood cell, but becomes toxic when outside of the cell membrane. In order to prevent agglutination during blood transfusions, ***blood typing*** must be performed to ensure the compatibility between donor and recipient. The blood recipient must not possess antibodies for the donor blood's antigens to ensure a successful transfusion. A person cannot have antibodies in their blood that will bind to the antigens on their red blood cells. We make antibodies only for antigens we ***do not have*** on our red blood cells. For example, a person with type **A** antigens cannot have **A**

antibodies in the bloodstream (plasma), but can have **B** antibodies. A person with type **B** blood cannot have **B** antibodies, but can have **A** antibodies. A person with type **AB** blood cannot have either **A** or **B** antibodies. A person with type O blood can have **A** *and* **B** antibodies in their blood stream.

Materials:

- 1 copy *Antibody Center Template**
- 5 copies *Antibody End Template**
- 1 copy *Antigens Template **
- 2 copies *Red Blood Cells Template**
- Construction paper
- Scissors
- Glue
- 3 Craft sticks per student (optional)

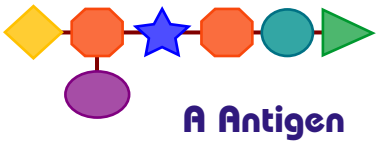
Activity Instructions: (Read each step and check off as completed.)

Part I. Antibodies and Antigens

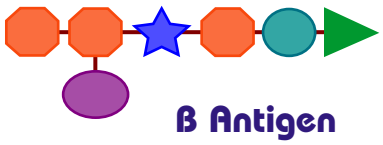
☐ 1. Gather your materials and assign an **A** or **B** antigen to each member of your group.

☐ 2. Construct one model of the antibody (or antibodies) that will bind to your assigned blood type antigen. (Remember, antibodies have very specific shapes and must be designed to fit antigens exactly.

a. Trace your assigned **A** or **B** antigen onto paper and cut out.



A Antigen



B Antigen

b. Trace Y-shaped antibody below onto paper and cut out.

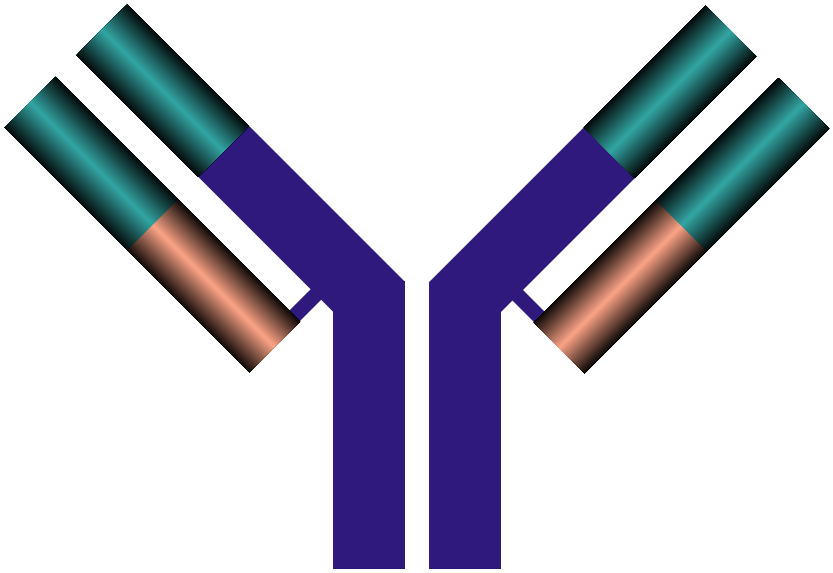


Figure 2 Y-shaped Antibody

c. Place antigen between chains of antibody and trace shape onto antibody as shown in Step A in figure 3.

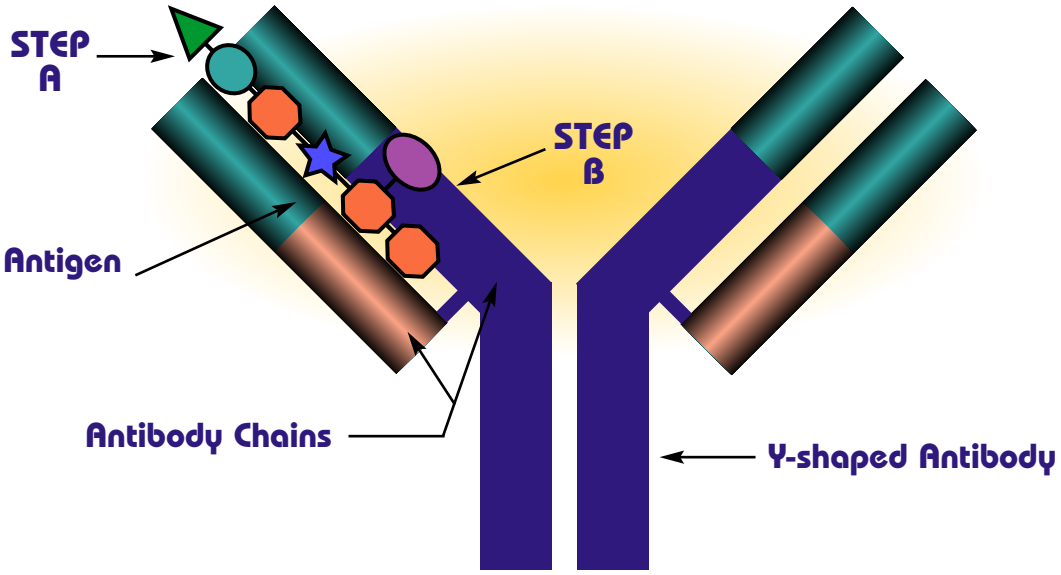


Figure 3 Tracing the Antigen

d. Cut out out shape as shown in Step C of figure 4.

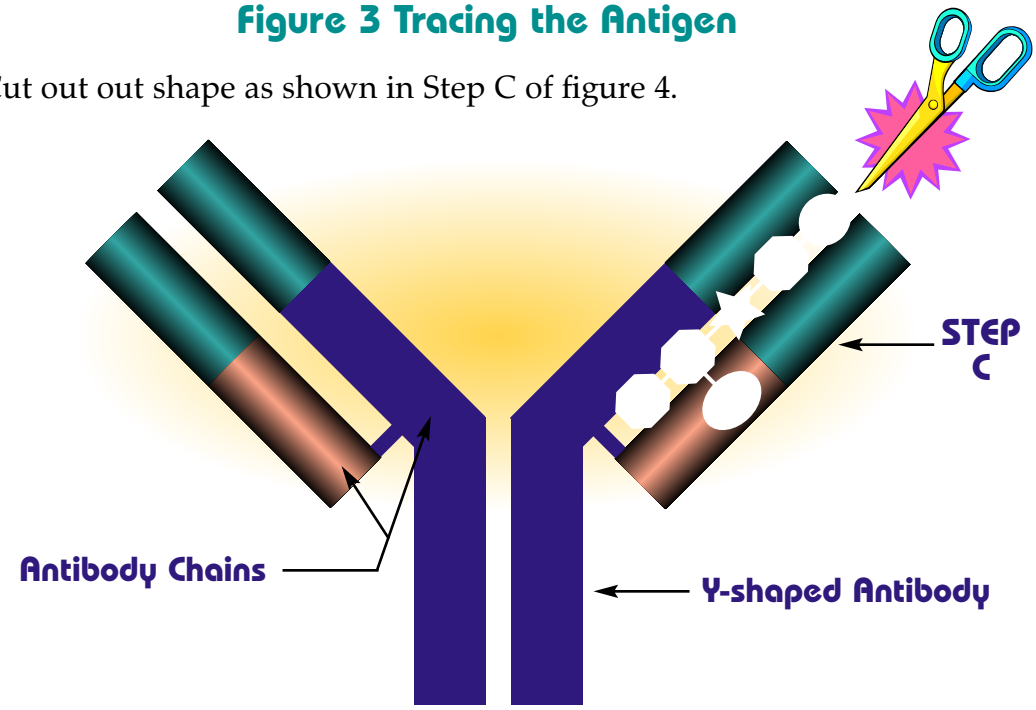


Figure 4 Designing Your Antibody

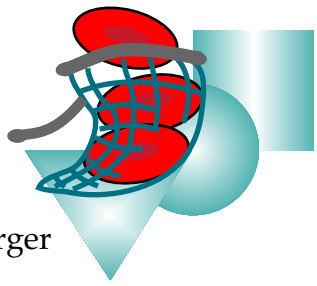
e. Repeat steps B – C for the remaining 2 chains of the antibody.

❒ 3. On your *Student Data Page*, draw the antibody you created and show how it connects to its antigen. Be sure to *label* the **A** and **B** antibodies and the **A** and **B** antigens.

❒ 4. Look at the antibodies created by the other members of your group. On your *Student Data Page*, draw the other type of antibody. Be sure to label whether it is an **A** antibody or a **B** antibody.

❒ 5. Now that you understand how antibodies and antigens work we will add a few more details.

Part II. Agglutination



1. Divide the templates from the *Template Pages* (provided by your teacher) evenly among your group. Cut out the pieces carefully. You should have 10 **A** antigens, 10 **A** antibody ends, 10 Red Blood cells and 1 IgM antibody templates after you finish cutting.
2. The Antibodies you cut out are actually the active ends of a much larger molecule called an IgM molecule. Attach your antibody ends to the designated place on the IgM molecule included on your *Template Page*. Note, it will take 5 antibody ends to fill the spaces on the IgM molecule.
3. Attach the antigens to the *Red Blood Cell Templates* in the designated places.
4. Take your completed antibody with 10 spaces for antigens to attach and "circulate" through the antigens in your group (attached to red blood cells). Attach as many antigens (with red blood cells) as possible to the antibody ends.
5. As you attach as many antigens as possible, notice what happens to the red blood cells.
6. On your *Student Data Page,* **Part I** draw a diagram showing how the antibodies and antigens attach, with the accompanying red blood cells.
7. Answer the questions on the *Student Data Page*. Be prepared to share your result and models with the class.
8. This process of agglutination is the basis of a test used to determine a person's blood type.

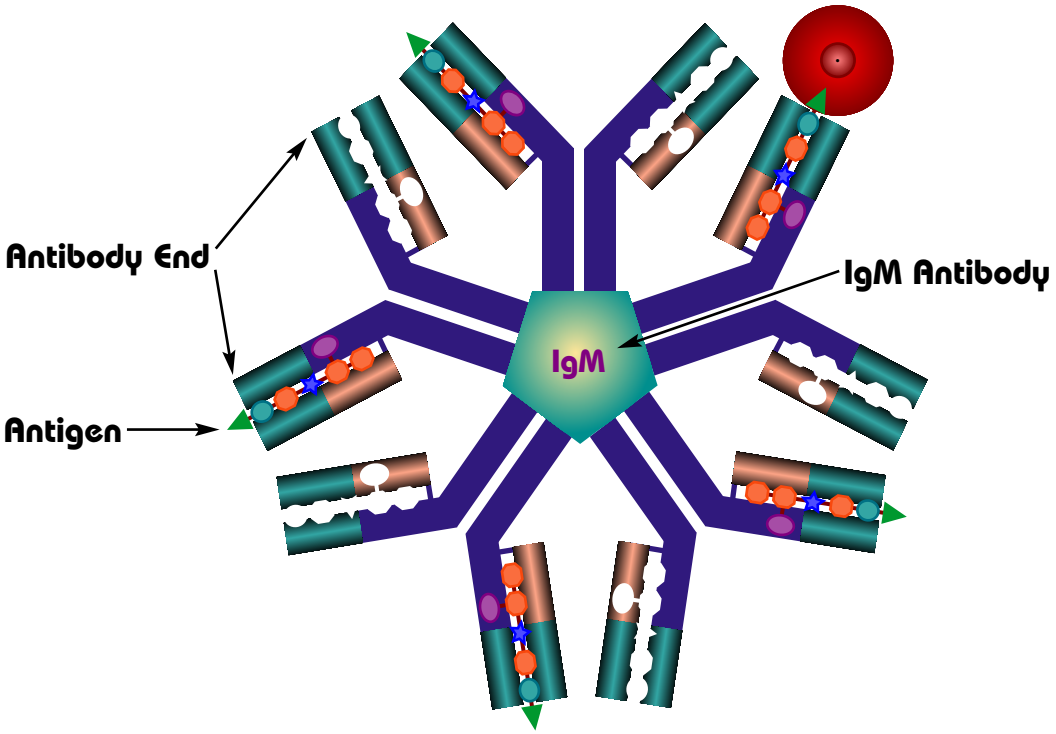


Figure 5 Agglutination