Hey, What's Your Type?

Student Information Page 3A

Activity Introduction:

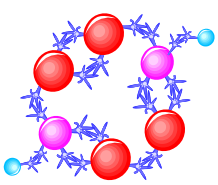
Did you ever wonder what people mean when they say they are "type A positive" or "type AB negative"? They are talking about their blood types. Everyone has special markers on their red blood cells that determine their blood type. In this activity, you will learn what causes the different blood types.

Activity Background:

Even though blood has been studied for thousands of years, the discovery of the ABO blood types was not made until the 20th century. In 1901, Dr. Karl Landsteiner identified the ABO blood group. Landsteiner found that there are four possible blood types within the ABO blood group and these blood types are determined by two different ***antigens***, A antigen and B antigen. An antigen is a molecule that can be recognized by the immune system and is capable of triggering the production of antibodies. These antigens are present on red blood cell membranes and other cells in our body. The ABO antigens are large ***carbohydrate*** molecules composed of smaller sugar molecules linked together.

The blood types are controlled by genes inherited randomly from our parents. ***Surprisingly, the antigens themselves are not the products of these genes***. Instead, the antigens are formed when changes are made in the antigen precursor molecules found on the surface of red blood cells. These changes to antigen precursor molecules are directed by enzymes produced by the genes. There are two genes directly involved in the production of the enzymes that generate the A and B antigens.

- The first gene is located on chromosome 19 and is called the ***H*** gene.
  - ***H*** gene produces an enzyme that can add ***fucose*** (a sugar molecule) to antigen precursor molecules on the red blood cells.
  - Once fucose has been added, enzymes from another gene on chromosome 9 can further modify the new H antigen.
- The second gene is located on chromosome 9 and has three variations; A, B, or O.
  - The A gene produces an enzyme that adds a sugar called ***GaINA*** to the H antigen to form A antigens and thus type A blood.
  - The B gene produces an enzyme that adds a sugar called ***galactose*** to the H antigen to form B antigen and thus type B blood.
  - The O gene does not produce any enzyme and does not alter the antigen precursor on the surface of the red blood cells. This means that neither A antigen nor B antigen is present, forming type O blood.



▼ The four blood types in the ABO blood group are:

A – People with type A blood have A antigens on their red blood cells.

B – People with type B blood have B antigens on their red blood cells.

AB – People with type AB blood have both A and B antigens on their red cells.

O – People with type O blood have neither the A nor the B antigen on their red blood cells.

You may have heard people say their blood type is B positive or B negative. The "positive" and "negative" refers to a different antigen on the surface of their red blood cells (RBCs). This antigen is the Rhesus factor or Rh factor. If the Rh factor **is** present on the RBCs, a person is positive for the Rh factor. If the Rh factor **is not** present on the RBCs, a person is negative for the Rh factor. Discovered in 1940 in the Rhesus monkey, Rh can cause complications during incompatible blood transfusions as well as in a pregnancy between an Rh incompatible mother and child. Although 45 different antigens have been identified to date, the Rh antigen is still the focus of research today.

Activity Materials: (per group)

- 1 copy of *Student Activity Pages*
- 1 copy of the *Molecule Template Page* copied onto colored paper if possible per student
- 1 copy of the *Student Data Pages* per student
- 1 pair scissors per student
- Glue
- 3 (6-inch) craft sticks per student
- 1 ruler per student
- 1 brad per student

Activity Instructions: Read each step and check off when completed.

I. Lookin' Around at Blood Types

☐ a. Cut out both parts of the wheel neatly.

☐ b. Insert a brad into the center of both wheels as instructed on the wheel page.

☐ c. Use the wheel to make observations and answer questions about which genes are present for each blood type and which antigens are present for each blood type. Record your observations in *Table 1 Genes, Antigens, and Blood Types* on your *Student Data Page*.

II. Creating Antigens (*antigens* are large molecules capable of being recognized by the immune system and triggering the production of antibodies)

- ❒ a. Gather your materials.
- ❒ b. Cut out all pieces from the ***Molecule Template Page***.
- ❒ c. Using the ***Blood Antigen Diagrams*** on your "Hey, What's Your Type" Wheel Cover, as a guide, arrange the cut out pieces on craft sticks so they are 1/4-inch apart (measure using a ruler). Be sure they are in the correct sequence as shown in the ***Blood Antigen Diagrams*** on the wheel cover.
- ❒ d. Begin with the ***Antigen Precursor*** diagram. This diagram represents a large molecule that must be present before any ABO antigens can be made by our body. Arrange the cutouts in correct sequence on 3 craft sticks to make 3 precursor molecules.
- ❒ e. Have a partner or your teacher check that the pieces are in the correct order, then glue them to the craft stick.

f. Once the ***Antigen Precursors*** are completed, another sugar molecule called ***fucose*** will be added to each stick to create 3 ***H antigens***. Look at the ***H Antigen*** on your wheel diagram and add the fucose cutout to your craft sticks as indicated. H antigens are created when people have the H gene.

g. Some people inherit a gene that can attach ***GaINA*** to the ***H Antigen***. The addition of GaINA creates a type ***A antigen***. Look at the ***A Antigen Diagram*** on your wheel cover and add a cutout of GaINA to one craft stick as indicated. You have made an ***A antigen***.

h. Repeat steps d-f on ***another*** craft stick. This time a ***galactose*** molecule will be added to the ***H Antigen*** as shown on the ***B Antigen Diagram*** on your wheel cover. Some people have a gene that can add galactose to the ***H Antigen***, making a ***B antigen***. Save your craft stick antigen models; you will use them in the next part of the activity.

III. ***Modeling blood types*** – The antigens you made in part II are important because they determine our A, B, AB, or O blood types. We inherit genes that make proteins to control the production of H, A and B antigens. These H, A and B antigens are located on our red blood cells and sometimes on other cells in the body. In this part of the activity, you will use your antigen models to create each of the four blood types.

a. Everyone has places for ***Antigen Precursors*** on their red blood cells, see ***Red Blood Cell Template*** on your ***Student Data Page***.

b. People with type A blood have A antigens on the surface of their red blood cells. Attach your A antigen model to the ***Red Blood Cell Template*** by fitting your antigen model into the notched area of the red blood cell. Draw your type A red blood cell on the ***Student Data Page***.

c. People with type B blood have B antigens on the red blood cells. Remove the A antigen from the ***Red Blood Cell Template***. Repeat step b using the B antigen. Draw your type B red blood cell on the ***Student Data Page***.

d. People with type AB blood have both A antigens and B antigens on the red blood cells. Repeat step b using both antigens. Draw your type AB red blood cell on the ***Student Data Page***.

e. People with type O blood do not have A antigens or B antigens on the red blood cells. They have only the ***H Antigen*** on the red blood cells. Repeat step b using your ***H Antigen*** model. Draw your type O red blood cell on the ***Student Data Page***.