Born of Blood: Inheritance of Blood Types
Activity 3C - Part 4

Activity Objectives:

Using curling ribbon models to simulate chromosomes, students will be able to:

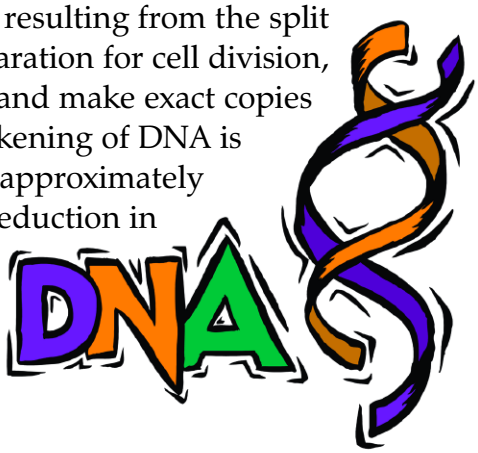
- Create models of chromosome 9, which contains the ABO genes
- Investigate the inheritance of the ABO blood type
- Predict blood types of offspring
- Demonstrate how chromosomes are related to Punnett Squares

Activity Description:

Students will create models of chromosome 9, which contains the ABO blood type genes. Using the chromosome models, they will create gene combinations for each of the 4 blood types. Finally, again using the chromosome models and a graphic organizer, students will simulate blood type inheritance and predict blood types that are possible from genetic crosses.

Activity Background:

Our blood type is a trait coded into our DNA, just as our eye color or hair color. All of our human traits are coded into genes found on 23 pairs (46) of chromosomes (strands of DNA and protein) kept in the nucleus of every cell in our body except red blood cells. Most of the time, our DNA is stretched out into long, thin strands and intertwined much like a bowl of spaghetti. The largest human chromosome would extend to 8.5 cm, the smallest 1.7 cm. When a cell gets ready to divide, it must prepare so that each of the 2 cells resulting from the split receive a complete set of DNA. In preparation for cell division, the chromosomes shorten and thicken and make exact copies of themselves. The shortening and thickening of DNA is very efficient, changing from 8.5 cm to approximately 5 micrometers in length (a 10,000 fold reduction in length). After an exact copy is made, the 2 chromosomes are held together at the centromere (DNA) by a kinetochore (protein).



Activity Overview

CAST YOUR NET: ADVENTURES WITH BLOOD

LESSON 3
ACTIVITY 3C

When the chromosomes are in this form, they are visible under a compound microscope, see *Figure 1 Chromosome Pairs (Dyads)*. Notice that each chromosome has a short arm and a long arm. When the cell divides, the duplicate strands of each chromosome separate and each cell gets one copy. This process occurs with each of our 46 chromosomes, so each daughter cell receives a full set of 46 chromosomes.

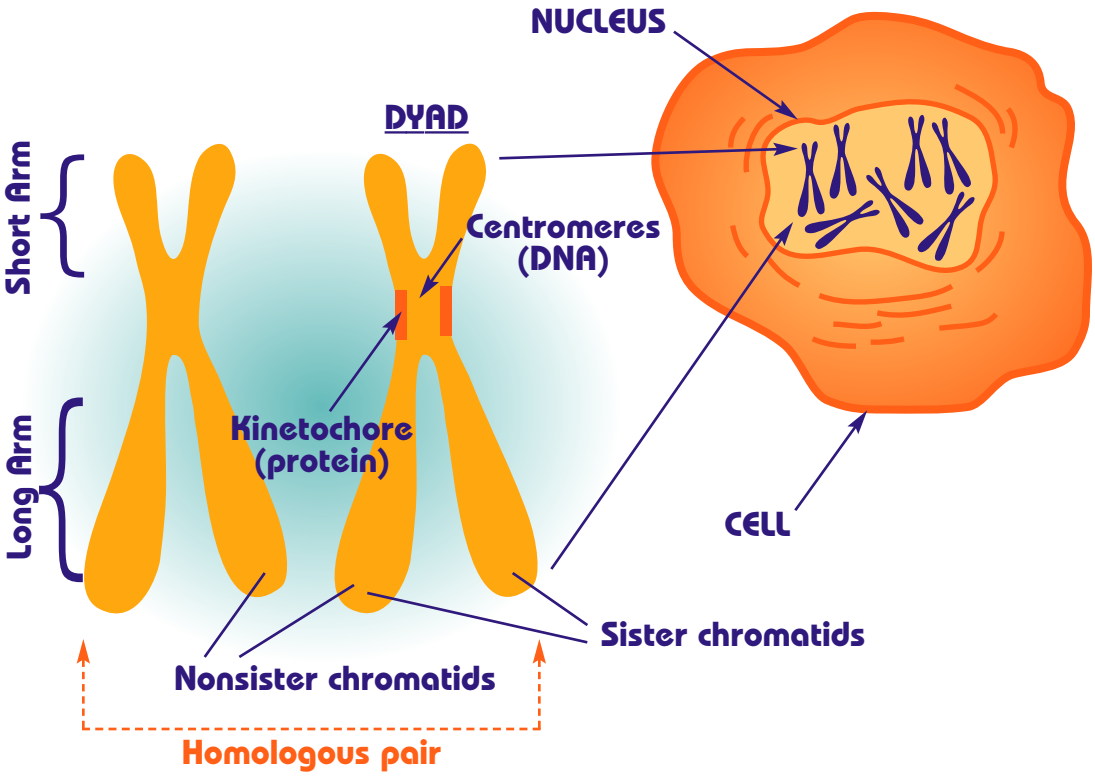


Figure 1 Chromosome Pairs (Dyads)

Our chromosomes exist as similar pairs (homologous), each containing genes for hundreds of traits. These pairs of chromosomes have genes for the exact same traits, but the information in the genes may differ. For example, if eye color is a trait located on a specific chromosome, both chromosomes in a pair will have a gene for eye color, but one gene may code for blue eyes and the other gene may code for brown eyes. So, every trait in our body is controlled by 2 genes, one inherited from our father and the other inherited from our mother. Genes are located in a particular sequence along the chromosomes.

In this activity, we are particularly interested in the ***ABO gene***, found on the long arm of chromosome 9. It was not until 1990 that this gene was discovered and the mapping of chromosome 9 was not completed until 2002; we now know it has approximately 1400 genes. There are three main variations of this blood type gene; A, B, and O.

- The A gene changes the antigens on our red blood cells into A antigens by adding a molecule of ***GaINAC*** to the H antigens found on almost everyone's red blood cells. This change creates Type A blood.

- The B gene changes the antigens on our red blood cells into B antigens by adding a molecule of ***galactose*** to the H antigens found on almost everyone's red blood cells. This change creates Type B blood.
- The O gene does not alter the H antigens found on almost everyone's red blood cells. This means that neither A nor B antigens are present, resulting in Type O blood.
- Most of the time, Type AB blood results from inheriting an A gene and a B gene so that both A and B antigens are created.

Activity Materials: (per group)

- 1 copy *Student Information Page*
- 1 copy *Student Data Page per student*
- 80 cm blue curling ribbon*
- 80 cm yellow curling ribbon*
- 80 cm red curling ribbon*
- Permanent marker
- Ruler
- Scissors
- (24) 3/8" diameter Velcro dots (Alternately cut six small pieces off of Velcro tape)
- Yellow, Blue and Red map pencils

**Note: Any three colors of curling ribbon can be used*

Activity Management Suggestions:

Make a transparency of the *Punnett Square Template* on page 15 so you can demonstrate how to use it on the overhead. Make laminated class sets of the *Punnett Square Template* and allow students to write on them with erasable transparency markers.

In demonstrating the use of this template, you can work the following sample problem:

What are the possible blood types of children born to a father with type AB blood and a mother with an A gene and an O gene (Type A blood)?

To demonstrate the use of the template, demonstrate the following steps:

Step 1: Since the father has type AB blood and the male chromosomes are at the top of the *Punnett Square Template*, place one red (Type A) set of duplicate chromosome models in one circle at the top of the template. Place a blue (Type B) set of duplicate chromosome models in the other circle at the top of the template. See *Figure 2 Placing Male Chromosomes on the Punnett Square Template*.

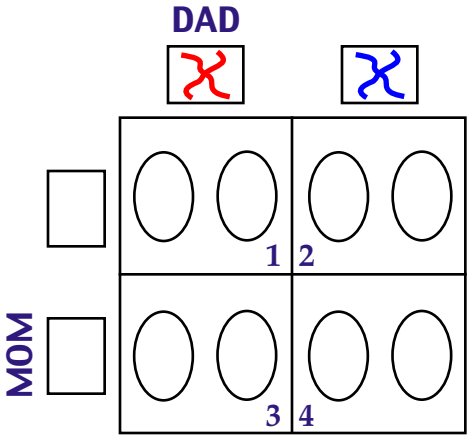


Figure 2 Placing Male Chromosomes on the Punnett Square Template

Step 2: The mother has Type A blood with one A gene and one O gene and the female chromosomes are located on the left side of the *Punnett Square Template*. Therefore, place one red (Type A) set of duplicate chromosomes in one circle along the left side of the template and one yellow (Type O) set of duplicate chromosomes in the other circle along the left side of the template. See *Figure 3 Placing Female Chromosomes on the Punnett Square Template*.

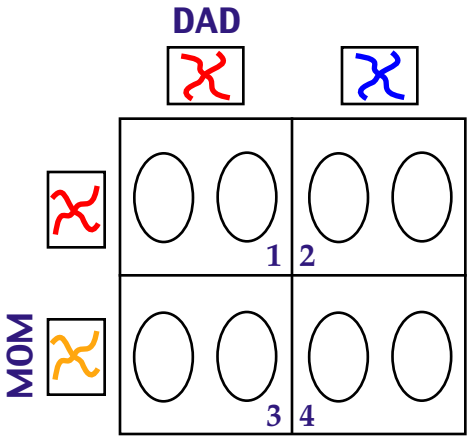


Figure 3 Placing Female Chromosomes on the Punnett Square Template

Step 3: To determine the gene combination of the first possible offspring, separate one of the red (Type A) chromosomes from the father and move it into the correct location as shown in *Figure 4 Creating the First Possible Gene Combination*. Next, move one red (Type A) chromosome from the mother as shown in *Figure 4 Creating the First Possible Gene Combination*. Write the blood type that will result from this genetic combination and then clear the first square and setup the Punnett Square Template as it was in Step 2.

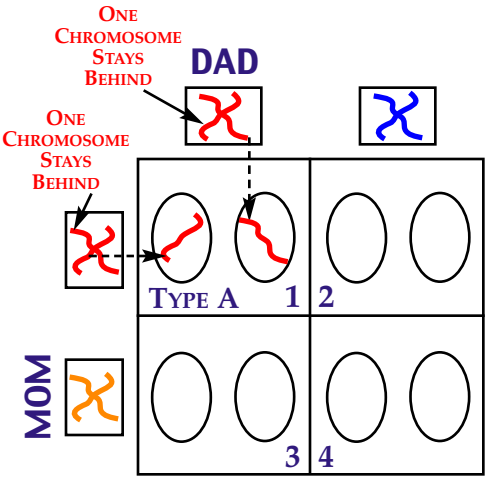


Figure 4 Creating the First Possible Gene Combination

Step 4: To determine the gene combination of the second possible offspring, separate one of the blue (Type B) chromosomes from the father and move it into the correct location as shown in *Figure 5 Creating the Second Possible Gene Combination*. Next, move one red (Type A) chromosome from the mother as shown in *Figure 5 Creating the Second Possible Gene Combination*. Write the blood type that will result from this genetic combination and then clear the first square and setup the Punnett Square Template as it was in Step 2.

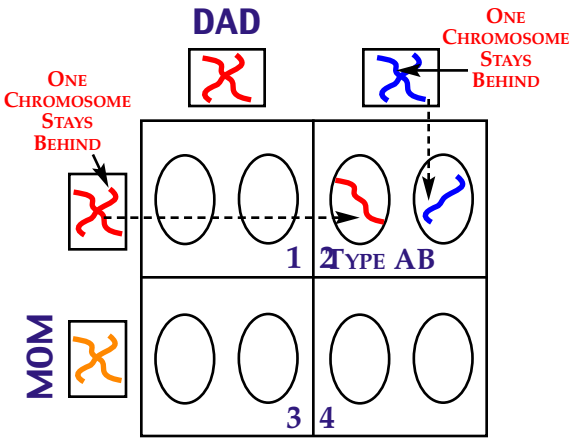


Figure 5 Creating the Second Possible Gene Combination

Step 5: To determine the gene combination of the third possible offspring, separate one of the red (Type A) chromosomes from the father and move it into the correct location as shown in *Figure 6 Creating the Third Possible Gene Combination*. Next, move one yellow (Type O) chromosome from the mother as shown in *Figure 6 Creating the Third Possible Gene Combination*. Write the blood type that will result from this genetic combination and then clear the first square and setup the Punnett Square Template as it was in Step 2.

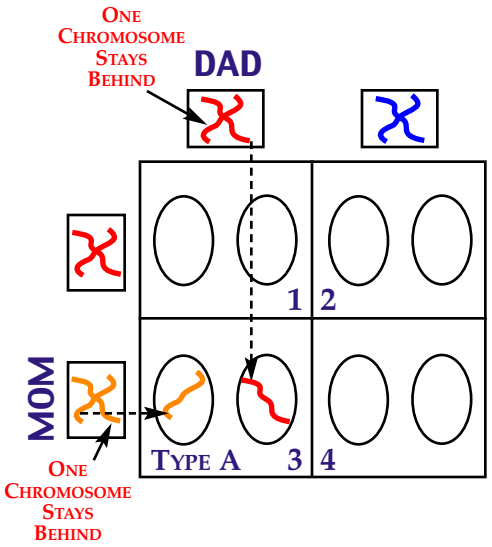


Figure 6 Creating the Third Possible Gene Combination

Step 6: To determine the gene combination of the fourth possible offspring, separate one of the blue (Type B) chromosomes from the father and move it into the correct location as shown in *Figure 7 Creating the Fourth Possible Gene Combination*. Next, move one yellow (Type O) chromosome from the mother as shown in *Figure 7 Creating the Fourth Possible Gene Combination*. Write the blood type that will result from this genetic combination and then clear the first square and setup the Punnett Square Template as it was in Step 2.

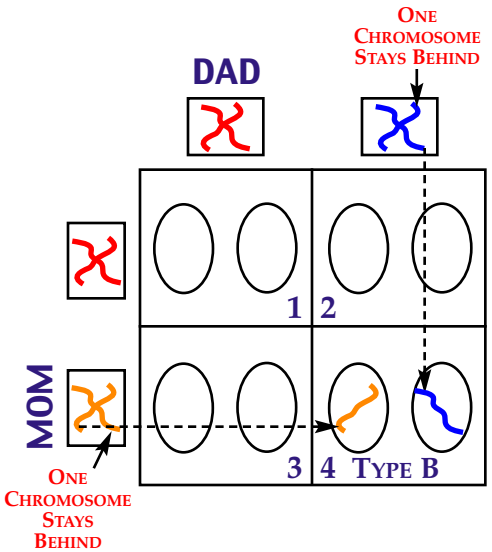


Figure 7 Creating the Fourth Possible Gene Combination

EXTENSIONS:

- Research other genes found on chromosome 9 using data from the Human Genome. What diseases/conditions are related to chromosome 9?
- Students can research a very rare situation in which two AB parents to have a child with blood type O; due to the "cis-AB" gene.
- Students can research a very rare Bombay blood phenotype

Activity References Used:

Bryant, Richard J. (2003). Toothpick chromosomes: Simple manipulatives to help students understand genetics. *Science Scope*; v26 n7 p10-15.

http://flysci. com/genome/genome_9. asp
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National Institutes of Health, Bethesda MD 20894, USA.
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