

Pre-Hardy-Weinberg Activity 3D

Activity Objectives:

Using red, blue and white poker chips, students will be able to:

- ◆ examine the inheritance of ABO blood groups
- ◆ simulate the change in frequency of alleles due to natural selection by using the class to represent a sample population

Activity Description:

By performing the lab, students will show how natural selection can alter the gene frequencies in a population.

Activity Background:

Even though blood has been studied for thousands of years, the discovery of the different blood types was not made until the 20th century. In 1901, Dr. Karl Landsteiner identified the three major *blood types* A, B, and O. Landsteiner found that each blood type is based on two different *antigens*, which are molecules capable of producing an immune response. The immune response begins by triggering the production of *antibodies*. Antibodies are Y-shaped proteins released into the blood or lymph in response to an antigen and can neutralize the antigen by binding to it.

The antigens that determine blood type are located on the surface of red blood cell membranes. They are composed of **glycoproteins** (molecules made of protein and carbohydrate) and **glycolipids** (which are molecules of fat and carbohydrate). Combinations of various antigens help make-up the four basic human blood types.



Blood types:



People with type A blood have A antigens on their red blood cells and produce antibodies against B antigens (B antibodies).



People with type B blood possess B antigens on their red blood cells and produce antibodies against A antigens (A antibodies).

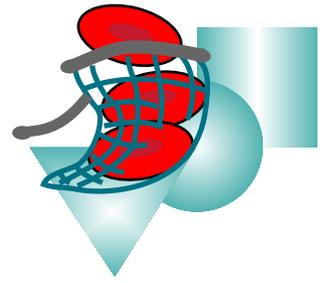


People with type AB blood have both the A and B antigens and do not produce antibodies for either antigen.



People with type O blood have neither the A nor B antigen on their red blood cell walls, but produce antibodies for both antigen types (A antibodies and B antibodies).

(For more information on the specific blood groups, see *Activity 3A* "Hey, What's Your Type?")



Activity Overview

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Blood type is an inherited trait. An individual receives two genes for each trait he/she inherits; one from mother and one from father. The different forms of a gene are called *alleles*. In the case of blood types, an individual could receive two genes for the A antigen in which case we would say he/she has received two A alleles and would be blood type A. If he/she inherited a gene for the A antigen from one parent and a gene for the B antigen from the other parent, that individual would have received an A allele and a B allele and would be blood type AB. If a person inherits two genes that keep him or her from making an A or B antigen, then he/she would be blood type O. See *Table 1* for the alleles in each blood type.

Table 1 Alleles in Each Blood Type

Type A:	AA,	AO
Type B:	BB,	BO
Type AB:	AB	
Type O:	OO	



Activity Materials:

- ◆ 10 red poker chips
- ◆ 10 blue poker chips
- ◆ 10 white poker chips
- ◆ 1 copy *Student Information Page* (per group)
- ◆ 1 copy *Student Data Page*

Activity Management Suggestions:

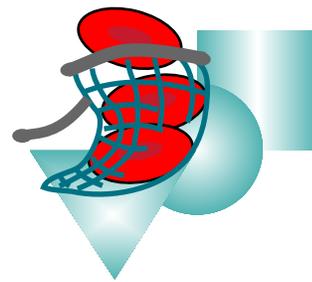
MODIFICATIONS:

For students needing more assistance: Group these students with peers who can assist them during the activity. Check often for understanding.

For highly able students: Allow these students to do research on the distribution of blood types and the ABO antigens. Students may also be grouped with other students to provide peer assistance.

EXTENSIONS:

- (1) Students can research the Hardy-Weinberg equation and how it is used.
- (2) Students can use blue poker chips to simulate the frequency of the B allele in both B and AB blood types.



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- (3) Students can use the poker chips to simulate the advantage heterozygous individuals have in some instances. For example, in some African populations, there is a high frequency of the sickle-cell allele. This is due to natural selection *for* the heterozygous genotype since these individuals are slightly more resistant to a deadly form of malaria than individuals who are homozygous dominant. Instructions for this simulation are included on the *Student Page*.

If students want more information about using four alleles in this simulation activity, have them research the process of meiosis.

Activity References Used:

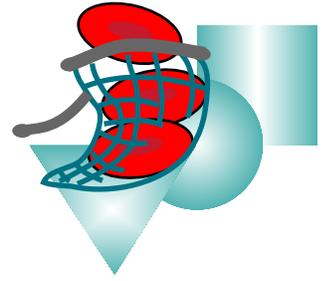
Behavioral Sciences Department, Palomar College, San Marcos, California website:

<http://anthro.palomar.edu/synthetic/Dunkers.htm>

http://anthro.palomar.edu/vary/vary_2.htm

Nelson, H. & Jurmain, R. (1988). Introduction to Physical Anthropology. West Publishing Co., St. Paul, MN.

Shachtman, T. (2006). *Medical Sleuth*. Smithsonian, 36, pp. 23-30.



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