Name: ______________________ Lab: ________

Lab 4 – Genetic Inheritance

Part 1 – Human Traits

Just as we inherit pairs of chromosomes, we inherit pairs of alleles, alternate forms of a gene. It is customary to designate an allele by a letter consistent with the specific characteristic it controls: A dominant allele is assigned a capital letter, while a recessive allele is given the same letter lowercased.

The genotype tells the alleles of the individual, while the phenotype describes the appearance of the individual.

Autosomal & Dominant and Recessive Traits

The alleles for autosomal characteristics are carried on the nonsex chromosomes. If individuals are homozygous dominant (AA) or heterozygous (Aa), their phenotype will be the dominant characteristic. If individuals are recessive (aa), their phenotype will be the recessive characteristic.

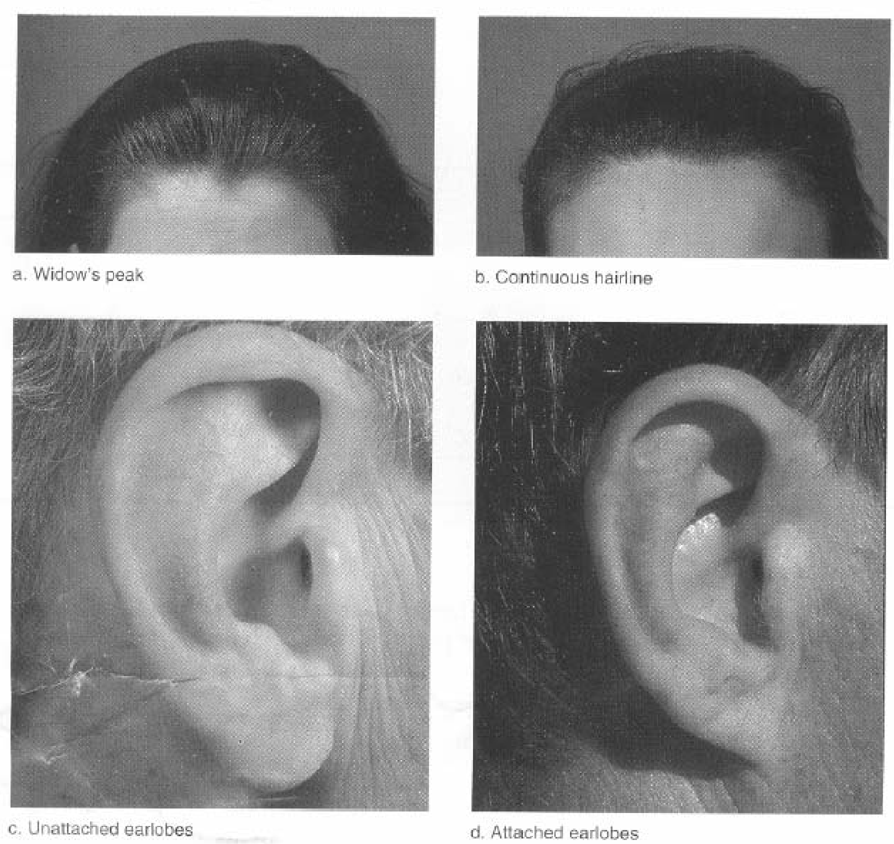


Figure 1 – Several examples of human phenotypes

Experimental Procedure Autosomal Traits

1. For this Experimental Procedure, you will need a lab partner to help you determine your phenotype for the characteristics listed in the first column of Table 1. Figure 1 illustrates some of these traits. Record your phenotypes by circling them in the first column of the table.

2. Determine your probable genotype. If you have the recessive phenotype, you know your genotype. If you have the dominant phenotype, you may be able to decide whether you are homozygous dominant or heterozygous by recalling the phenotype of your parents, siblings, or children. Circle your probable genotype in the second column of Table 1.

3. Your instructor will tally the class's phenotypes for each trait so that you can complete the third column of Table 1.

4. Complete Table 1 by calculating the percentage of the class with each characteristic. Are dominant phenotypes always the most common in a population? _______
Explain.

Table 1 – Autosomal Human Traits

Characteristic: d = Dominant, r = Recessive	Possible Genotypes	Number in Class	Percentage of Class with Trait
Hairline:			
Widow's peak (d)	*WW* or *Ww*	______	______
Straight hairline (r)	*ww*		
Earlobes:			
Unattached (d)	*UU* or *Uu*	______	______
Attached (r)	*uu*		
Skin pigmentation:			
Freckles (d)	*FF* or *Ff*	______	______
No freckles (r)	*ff*		
Hair on back of hand:			
Present (d)	*HH* or *Hh*	______	______
Absent (r)	*hh*		
Thumb hyperextension—"hitchhiker's thumb":			
Last segment cannot be bent backward (d)	*TT* or *Tt*	______	______
Last segment can be bent back to 60° (r)	*tt*		
Bent little finger:			
Little finger bends toward ring finger (d)	*LL* or *Ll*	______	______
Straight little finger (r)	*ll*		
Interlacing of fingers:			
Left thumb over right (d)	*II* or *Ii*	______	______
Right thumb over left (r)	*ii*		

Genetics Problems

1. Nancy and the members of her immediate family have attached earlobes. Her maternal grandfather has unattached earlobes. What is the genotype of her maternal grandfather? ______ Nancy's maternal grandmother is no longer living. What could have been the genotype of her maternal grandmother? ______________

2. Joe does not have a bent little finger, but his parents do. What is the expected ratio among the parents' children?

3. Henry is adopted. He has hair on the back of his hand. Could both of his parents have had hair on the back of the hand? ________ Could both of his parents have had no hair on the back of the hand? Explain.

Part 2 - Testing Familial Relationships Using Simulated Blood Lab Activity

BACKGROUND

Around 1900, Karl Landsteiner discovered that there are at least four different kinds of human blood, determined by the presence or absence of specific agglutinogens (antigens) on the surface of red blood cells (erythrocytes). These antigens have been designated as A and B. Antibodies against antigens A or B begin to build up in the blood plasma shortly after birth, the levels peak at about eight to ten years of age, and the antibodies remain, in declining amounts, throughout the rest of a person's of life. The stimulus for antibody production is not clear; however, it has been proposed that antibody production is initiated by minute amounts of A and B antigens that may enter the body through food, bacteria, or other means. Humans normally pro duce antibodies against those antigens that are not on their red blood cells: a person with A antigens has anti-B antibodies; a person with B antigens has anti-A antibodies; a person with neither A nor B antigens has both anti-A and anti-B antibodies; and a person with both A and B antigens has neither anti-A nor anti-B antibodies (Figure 1). Blood type is based on the antigens, not the antibodies, a person possesses.

The four blood groups are types A, B, AB, and 0. Blood type 0, characterized by the absence of A and B agglutinogens, is the most common in the United States and is found in 45% of the population. Type A is next in frequency, and is found in 39% of the population. The frequencies at which types B and AB occur are 12% and 4% respectively.

Figure 1

Blood Type	Antigens on Erythrocytes (Agglutinogens)	Antibodies in Plasma (Agglutinins)	Can Give Blood To	Can Receive Blood From
A	A	Anti-B	A, AB	O, A
B	B	Anti-A	B, AB	O, B
AB	A and B	Neither Anti-A nor Anti-B	AB	O, A, B, AB
O	Neither A nor B	Both Anti-A and Anti-B	O, A, B, AB	O

How Does a Blood Test Work?

There is a simple test performed with antisera containing high levels of anti-A and anti-B agglutinins to determine blood type. Several drops of each kind of antiserum are added to separate samples of blood. If agglutination (clumping) occurs only in the suspension to which the anti-A serum was added, the blood type is A. If agglutination occurs only in the anti-B mixture, the blood type is B. Agglutination in both samples indicates that the blood type is AB. The absence of agglutination in any sample indicates that the blood type is 0 (Figure 2).

Figure 2
Agglutination Reaction of ABO Blood-Typing Sera

Reaction		Blood Type
Anti-A Serum	**Anti-B Serum**	
Agglutination	No Agglutination	A
No Agglutination	Agglutination	B
Agglutination	Agglutination	AB
No Agglutination	No Agglutination	O

The Genetics of Blood Types

The human blood types (A, B, AB, and 0) are inherited by multiple alleles, which occurs when three or more genes occupy a single locus on a chromosome. Gene I^A codes for the synthesis of antigen (agglutinogen) A, gene I^B codes for the production of antigen B on the red blood cells, and gene i does not produce any antigens. The phenotypes listed in the table below are produced by the combinations of the three different alleles: I^A, I^B, and i. When genes I^A and I^B are present in an individual, both are fully expressed. Both I^A and I^B are dominant over i so the genotype of an individual with blood type 0 must be ii (Figure 3).

Figure 3

Phenotype	Possible Genotypes
A	I^AI^A I^Ai
B	I^BI^B I^Bi
AB	I^AI^B
O	ii

Use I^A for antigen A, I^B for antigen B, and i for no antigens present.
Genes I^A and I^B are dominant over i.
AB blood type results when both genes I^A and I^B are present.

OBJECTIVES

- Perform the ABO blood typing procedure
- Determine the ABO blood types of two sets of parents and two newborn children
- Examine the genetic relationships possible between the parents and children
- Match the "mixed up" children with their proper parents

MATERIALS

6 Blood typing slides
6 Simulated blood samples
    Mr. Smith
    Mrs. Smith
    Mr. Jones
    Mrs. Jones
    Child 1
    Child 2
Simulated Anti-A Serum
Simulated Anti-B Serum

PROCEDURE

Scenario

Two children, born in a hospital at approximately the same time, may have been "mixed up" in the nursery. The parents of the children have volunteered to give blood samples to help determine whether or not this is the case.

1. Obtain six blood typing slides. Label each blood typing slide:
Slide #1: Mr. Smith
Slide #2: Mrs. Smith
Slide #3: Mr. Jones
Slide #4: Mrs. Jones
Slide #5: Child 1
Slide #6: Child 2

2. Place two to three drops of Mr. Smith's blood in each of the A and B wells of Slide #1.

3. Place two to three drops of Mrs. Smith's blood in each of the A and B wells of Slide #2.

4. Place two to three drops of Mr. Jones's blood in each of the A and B wells of Slide #3.

5. Place two to three drops of Mrs. Jones's blood in each of the A and B wells of Slide #4.

6. Place two to three drops of Child l's blood in each of the A and B wells of Slide #5.

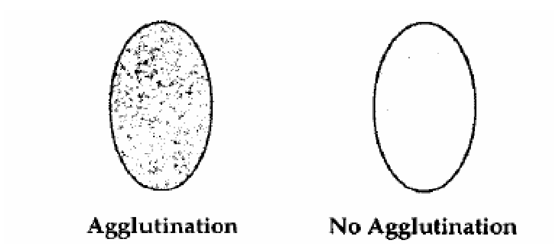
7. Place two to three drops of Child 2's blood in each of the A and B wells of Slide #6.

8. Place two to three drops of the simulated anti-A serum in each A well on the six slides.

9. Place two to three drops of the simulated anti-B serum in each B well on the six slides.

10. Stir each slide for 30 seconds. Be careful not to make the solutions move out of the slides.

11. Examine each well for agglutination. To confirm agglutination try reading text through the mixed sample. If you cannot read the text, assume you have a positive agglutination reaction. Record your observations in Table 1 in the Analysis section of the lab.



12. Determine possible genotypes of all six individuals. Record the results in Table 2 in the Analysis section.

Slide #	Name	Anti-A	Anti-B	Blood Type	Possible Genotypes
1	Mr. Smith				
2	Mrs. Smith				
3	Mr. Jones				
4	Mrs. Jones				
5	Child 1				
6	Child 2				

Questions

1. Could Child 1 have been born to Mr. and Mrs. Smith? Why or why not? How about Child 2?

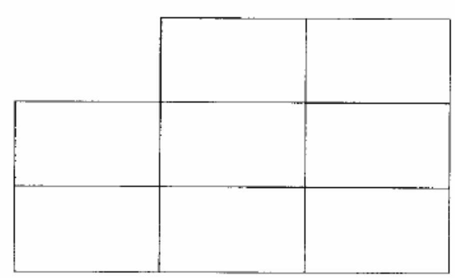
2. Could Child I have been born to Mr. and Mrs. Jones? Why or why not? How about Child 2?

3. What conclusions can you draw from the evidence in questions 2 and 3?

4. As determined above, the child belonging to Mr. and Mrs. Smith has blood type B. Does this mean all children born to Mr. and Mrs. Smith will have blood type B? Explain.

5. Two parents, genotypes I^AI^B and I^Bi, produce a child. Determine what the probability is that the child may display each of the four ABO blood types. Use the Punnett square below.

Type A: ____%
Type B: ____%
Type AB:____%
Type O: ____%



6. You are a lawyer representing a man with blood type B. A woman of blood type 0 has a child with blood type A and is proposing that the man fathered the child. Using what you have learned about blood typing and genetics, briefly state your argument to the jury in defense of your client.