

## Lab 8: Genetic Characteristics and Blood Typing

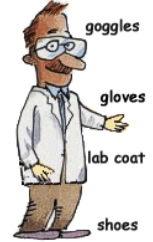
Name \_\_\_\_\_

Date \_\_\_\_\_

Lab safety: Full PPE required for this lab - lab coat, long pants, closed-toe shoes, gloves and safety goggles

### Learning Objectives:

1. Understand the mechanisms of Mendelian Genetics.
2. Observe and record phenotypes which occur in humans.
3. Perform simulations of standard tests used for blood type identification.
4. Understand the importance of blood type identification and its uses.
5. Learn about the structural characteristics of some blood components that make the blood test work.



### Pre-Lab Activity:

#### Part A: Mendelian Inheritance:

Read through the laboratory handout [Introduction Part A](#) and refer to the TED-Ed video at the provided link <https://www.youtube.com/watch?v=Mehz7tCxjSE> (How Mendel's pea plants helped us understand genetics) to help answer the following questions before coming to lab.

1. Define the following terms:
  - a. Phenotype
  - b. Genotype
  - c. Allele
  - d. Chromosome
  - e. Gene
  - f. Dominant Trait
  - g. Recessive Trait
2. Why did Mendel study pea plants? What made them a good organism to study?
3. Describe the differences between dominant traits and recessive traits.
4. How are the terms homozygous and heterozygous different?
5. Which of the following can be observed more easily—genotype or phenotype? Explain your answer.

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### Part B: Blood Typing

Read through the laboratory handout Introduction Part B to help answer the following questions before coming to lab.

1. Define **codominance**
2. Shown in the table below are the antigens present on the blood cells of 4 different people. Fill in the corresponding ABO blood type for each person and the antibodies expected to be found in each person's serum (blood).

| Blood Type | Red Cell Antigen | Antibody in Blood Plasma |
|------------|------------------|--------------------------|
|            | A                |                          |
|            | B                |                          |
|            | A and B          |                          |
|            | Neither A nor B  |                          |

### Introduction Part A: Genetics

Genetics is the study of heredity, or the passing of traits from parents to offspring. **Genes** (specific segment of a DNA molecule that holds the information for one specific protein) come in different versions, or **alleles**. Humans are called diploid organisms because they have two alleles at each genetic locus (location), with one allele inherited from each parent. Each pair of alleles represents the (**genotype**, combination of alleles) of a specific gene. Genotypes are described as **homozygous** if there are two identical alleles at a particular locus and as **heterozygous** if the two alleles differ. A **dominant** allele hides a **recessive** allele and determines the organism's appearance (**phenotype**, set of observable traits). In other words, an organism only needs one dominant allele to express a dominant trait, but would require two recessive alleles to express a recessive trait. Dominant alleles are represented with a capital letter (R), while recessive alleles are represented with a lowercase letter (r).

Gregor Mendel's Principle of Segregation states that pairs of genes segregate during the formation of gametes (meiosis), so that each gamete has one of each gene pair but not both. The Principle of Independent Assortment states that each gene pair is distributed (assorts) independently of other gene pairs during the formation of gametes (meiosis). These principles laid the foundation for the study of inheritance that continues today.

### Activity 1: Mendelian Inheritance in Humans

Many human traits follow Mendelian inheritance predictions. A number of human inheritance traits are listed below. Most appear to be "controlled" by a single gene that has two alternative alleles (specific forms of a gene). In each, one allele is dominant and the alternative is recessive. Your genotype is the specific combination of alleles you inherit from your biological parents. It can be homozygous dominant, heterozygous or homozygous recessive. Your phenotype is what is expressed, and for "visually observable" genes, what we see.

#### Materials Needed

For a team of four students, you need:

- 4 Phenylthiocarbamide (PTC) paper strips

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### Procedure

For each of the following 11 traits (see Figure 1) determine your phenotype and enter in into the table provided. Based on your phenotype, record your possible genotypes for each of the traits. Remember that if you have a recessive characteristic you must have both recessive alleles, but if you have a dominant characteristic you may be either homozygous dominant or heterozygous. In this case you have no way of knowing whether you carry a recessive allele, use a dash (-) to represent the unknown second gene.

*Figure 1 (2 pages). Review of description and visualization of Traits*

- **Dimpled chin**

- A cleft in the chin is a dominant trait
  - D – dimple
  - d – no dimple



Cleft Chin

Smooth Chin

- **Free ear lobe**

- Ear lobes that hang free and are NOT attached directly to the head are dominant
  - E – free ear lobes
  - e – attached ear lobes



Attached earlobe

Free earlobe

- **Widow's peak**

- A hairline that forms a distinct point in the center of the forehead is dominant
  - W – widow's peak
  - w – no widow's peak



- **PTC Tasting**

- The ability to taste the bitterness associated with phenylthiocarbamide (PTC) is dominant
  - T – taster
  - t – non taster



- **Interlocking Fingers**

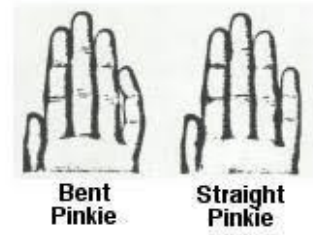
- Having one's LEFT thumb on top when fingers are interlocked is dominant
  - I – left thumb
  - i – right thumb



- **Bent little finger**

- Dominant when the last joint of the little finger bends inward towards the fourth finger

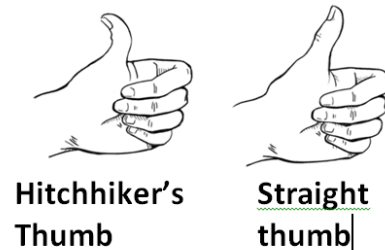
- B – bent finger
- b – straight finger



- **Hitchhiker's thumb**

- Not being able to bend your last thumb joint back to almost a 90° angle is dominant

- H – normal thumb
- h – hitchhiker's thumb



- **Long palmar muscle**

- Having only two tendons in your wrist is dominant

- L – two tendons
- I – three tendons – long palmar muscle



- **Freckles**

- The presence of freckles is dominant over absence of freckles.

- F – freckles
- f – no freckles



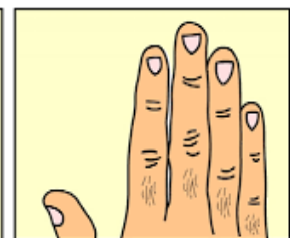
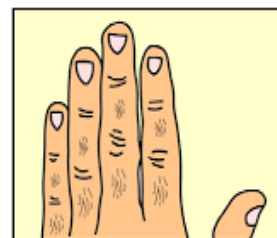
**Freckles**

**No freckles**

- **Mid-digital hair**

- Having hair on the second joint of one or more of the fingers is dominant

- M – mid-digital hair
- m – No mid-digital hair



**Mid-Digital Hair Present**

**Mid-Digital Hair Absent**

- **Tongue Curling**

- The ability to curl the tongue upward from the sides is a dominant trait

- C – tongue curls
- c – tongue does NOT curl



**Can Roll Tongue**

**Can't Roll Tongue**

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**Table 1: Genetic Traits**

| Characteristic          | Your Information |          | Data from entire class |            |
|-------------------------|------------------|----------|------------------------|------------|
|                         | phenotype        | genotype | # phenotype            | percentage |
| Dimpled chin - D        |                  |          |                        |            |
| Nondimpled chin - d     |                  |          |                        |            |
| Free ear lobes – E      |                  |          |                        |            |
| Attached ear lobes – e  |                  |          |                        |            |
| Widow's peak – W        |                  |          |                        |            |
| No widow's peak - w     |                  |          |                        |            |
| PTC taster – T          |                  |          |                        |            |
| PTC Non-taster – t      |                  |          |                        |            |
| Left thumb on top – l   |                  |          |                        |            |
| Right thumb on top – i  |                  |          |                        |            |
| Bent little finger – B  |                  |          |                        |            |
| Straight finger – b     |                  |          |                        |            |
| Normal thumb – H        |                  |          |                        |            |
| Hitchhiker's thumb – h  |                  |          |                        |            |
| Two tendons – L         |                  |          |                        |            |
| Three tendons – l       |                  |          |                        |            |
| Freckles – F            |                  |          |                        |            |
| No Freckles - f         |                  |          |                        |            |
| Mid-digital hair – M    |                  |          |                        |            |
| No mid-digital hair – m |                  |          |                        |            |
| Tongue curling – C      |                  |          |                        |            |
| No tongue curling - c   |                  |          |                        |            |

Questions:

1. For the traits observed did you find the dominant alleles were expressed most often?
2. For which traits was this not true?
3. **How individual are we?** (Whole class activity)
  - a. Pick a person in your class to serve as an “individual.”
  - b. Everyone stands up
  - c. The individual calls out his/her phenotype for each trait.
  - d. All the students that have a different phenotype from the “individual” can then sit down.
4. How many characteristics does it take for the “individual” to stand out as unique?
5. In a country where there has been little immigration, would you expect an individual to stand out sooner or later than what occurred in class?

**Introduction Part B: Blood Types**

Although the basic composition and function of blood in each individual is the same, there are different human blood types. People can have one of four types of blood: **A**, **B**, **AB**, or **O**. A blood type is based on the presence of enzymes that determine the type of carbohydrates (A, B) or absence of these carbohydrates (O) on the surface of the red blood cells. Because there are two types of carbohydrates involved and both can be expressed on the same cell (**codominant inheritance**) there are four possible combinations or blood types (ABO groups), shown in **Figure 2**. These carbohydrates can result in an immune response, so they are often referred to as **antigens**.








|                   | Type A   | Type B   | Type AB  | Type O   |
|-------------------|--|--|--|--|
|                   | Antigen A  | Antigen B  | Antigens A and B   | Neither A nor B antigens   |
| Red blood cells   |       |       |  |             |
| Plasma antibodies | <br>B | <br>A | Neither A nor B  | <br>A and B |

Figure 2: Blood Types

**Table 2 : Relationships of the ABO Blood Types to the presence of antigens and antibodies in the blood.**

| Blood Group | Antigen Present on Cells | Antibody in the Blood Plasma |
|-------------|--------------------------|------------------------------|
| A           | A                        | Anti-B                       |
| B           | B                        | Anti-A                       |
| AB          | A and B                  | Neither                      |
| O           | Neither                  | Anti-A and Anti-B            |

In addition to carbohydrates, there are also proteins found on the surface of red blood cells that can cause an immune response. One common type is the Rh factor. The Rh factor is either present (+) or absent (-). So, blood types are described as the type (carbohydrates present) and the presence of the Rh factor (i.e., O+, A+, AB-).

The molecules (carbohydrates and proteins) that are expressed on your red blood cells allow your cells to make **antibodies** to protect against foreign cells. Your cells make antibodies against the proteins NOT expressed on your red blood cell surface (**Table 2**). If two different blood types are mixed together during a transfusion, the blood cells may begin to clump together (**agglutinate**) in the blood vessels, possibly causing death. This clumping is due to the antibodies in your body binding to the foreign molecules (antigens) on the surface of the foreign red blood cells. Therefore, it is important that blood types be matched before blood transfusions take place.

Type O- blood is referred to as the universal donor as it has neither A, B, or Rh antigens on their red blood cells. However they cannot receive blood from any donors, other than O- as they have antibodies for A and B in the blood plasma. Type AB+ is the universal acceptor because they have no antibodies in the blood serum to cause an immune reaction.

### Activity 2: ABO-Rh Blood Typing

In this lab you will determine the blood type of four different synthetic blood samples using antisera to the A, B, and Rh(D) antigens that exist on human red blood cells. The procedure is the same that would be used for a real blood test, but for convenience and safety, the samples are synthetic and do not contain any biological materials.

#### Materials Needed

For a team of four students, you need:

- Vial (1 each) of synthetic anti-A serum, anti-B serum and anti-D (anti-Rh) serum
- Vial (1 each) of synthetic blood for Samples 1- 4.
- Blood typing trays (4)
- Mixing sticks
- Paper towels

#### Procedure

1. Using the dropper vial, place a drop of the first synthetic blood sample in each well of the blood typing slide. Replace the cap on the dropper vial. Always replace the cap on one vial before opening the next vial to prevent cross contamination.

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2. Add a drop of synthetic anti-A (blue) to the well labeled A. Replace the cap.
3. Add a drop of synthetic anti-B serum (yellow) to the well labeled B. Replace the cap.
4. Add a drop of synthetic anti-Rh serum (clear) to the well labeled Rh. Replace the cap.
5. Using a different color mixing stick for each well (blue for anti-A, yellow for anti-B, white for anti-Rh), gently stir the synthetic blood and anti-serum drops for 30 seconds. Remember to discard each mixing stick after a single use to avoid contamination of your samples.
6. Carefully examine the thin films of liquid mixture left behind. If a film remains uniform in appearance, there is no agglutination. If the sample appears granular and/or thick, agglutination has occurred.
7. Determine the blood type of the sample using the data table below. Answer yes or no as to whether agglutination occurred in each sample. A positive agglutination reaction indicates the blood type.
8. Record the results for the first blood sample in the data table.
9. Repeat steps 1 through 7 for synthetic blood samples 2, 3, and 4.

**Table 3: Collected Results for Blood Typing Simulation**

|                   | Sample 1 | Sample 2 | Sample 3 | Sample 4 |
|-------------------|----------|----------|----------|----------|
| Anti –A           |          |          |          |          |
| Anti –B           |          |          |          |          |
| Rh                |          |          |          |          |
| <b>Blood Type</b> |          |          |          |          |

### Cleaning:

Wash all the blood sample trays with soap and water. If there is any stain, wipe with isopropyl alcohol.

Throw all the sticks and paper towels in the trash.

Wash your hands properly.

### Reference:

Helms et al., Organic Molecules, Biology in the Laboratory 3<sup>rd</sup> Edition 1998

ABO-Rh Blood Typing With Synthetic Blood, Carolina Biologicals Supply Company

Michael D. Johnson, Human Biology Concepts and Current Issues Laboratory Manual, 6<sup>th</sup> edition, 2012.

Pictures from: google.com



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### Post-Lab Activity:

Name \_\_\_\_\_

Answer the following questions.

1. What is the phenotype of a person with the genotype *EETT*?
2. What is the phenotype of a person with the genotype *eett*?
3. What is the phenotype of a person with the genotype *EeTt*?
4. If 4 out of 10 students cannot roll their tongue, what percentage of students are recessive (see Figure 1)?
5. Name the antigens and antibodies present in type A+ blood.
6. Name the antigens and antibodies present in type O- blood.
7. What does clumping mean in blood typing tests?
8. Which individuals are considered universal donors, why?
9. Which individuals are considered universal acceptors, why?
10. What blood types could an individual with type A- receive?