

Name: \_\_\_\_\_

Section: \_\_\_\_\_

## **Part I - Natural Selection Evolution Lab**

### **General Overview:**

Charles Darwin is universally associated with evolutionary theory. His major contribution was to describe the primary mechanism by which it worked: **natural selection**. Darwin said that it is the forces of nature that select species to survive that are best adapted to the environment. These species in turn produce offspring and their numbers increase. Darwin proposed four tenets by which natural selection operates:

1. Genetic variation.
2. Overproduction of offspring.
3. Struggle for existence.
4. Differential survival and reproduction.

In this lab, you will complete two exercises that illustrate natural selection.

### **I. Mimicking Natural Selection**

#### **Introduction:**

We know from the fossil record that species evolve over time. Darwin argued that the primary mechanism of evolutionary change is the process of **natural selection**. Natural selection occurs because individuals with certain traits or adaptations have greater survival and reproduction than individuals who lack those traits or adaptations. Selection that favors one extreme characteristic over the other is known as *directional selection*. When selection favors an intermediate characteristic rather than one of the extremes, it is known as *stabilizing selection*. Selection that operates against the intermediate characteristic and favors the extremes is called *disruptive selection*.

In this exercise, you will use a simulation to study how natural selection works by looking at the survival rate of differently colored “prey” in a pond. The prey will be represented by different colored beads. Dark green and clear colored beads represent the two extreme characteristics, while light green colored beads represent the intermediate characteristic. The “predator” will be represented by forceps used to catch the prey.

#### **Materials:**

Dishpan  
dark green/light green/clear beads  
blue, red, and green food coloring,  
forceps

**Methods:**

1. Working in groups of four, establish the initial population by placing 10 dark green, 10 light green, and 10 clear beads into a dishpan filled  $\frac{3}{4}$  full of water that has been darkened with blue, red and green food coloring. The water should appear dark brown.
2. One student is the predator. The predator searches the pond and removes as many prey as possible in **30** seconds. In order to more closely model the handling time required by real predators, you must search for and remove beads with forceps.
3. Count the number of each prey color removed and record it in Table 1. Calculate the number of surviving prey for each color. Also calculate the prey's reproductive success by adding 1 offspring for each surviving prey. Add the offspring to the surviving population of prey in the pond. This will be your new population in the next generation.
4. Repeat steps 2 – 3 six more times for a total of seven generations. **Note – do not add any new offspring after the 2<sup>nd</sup> generation.**
5. Record your data in the tables present in the Mimicking Natural Selection Worksheet and complete the worksheet.

Name: \_\_\_\_\_

Section: \_\_\_\_\_

**Mimicking Natural Selection Worksheet**

- Record your results in the tables provided.

Table 1. First Generation

	<b>Dark green prey</b>	<b>Medium green prey</b>	<b>Clear prey</b>
<b>Initial population</b>	<b>10</b>	<b>10</b>	<b>10</b>
<b>Killed prey</b>			
<b>Surviving prey</b>			
<b>Number of offspring</b>			
<b>Next generation total number</b>			

Table 2. Second Generation

	<b>Dark green prey</b>	<b>Medium green prey</b>	<b>Clear prey</b>
<b>Initial population</b>			
<b>Killed prey</b>			
<b>Surviving prey</b>			
<b>Number of offspring</b>			
<b>Next generation total number</b>			

Table 3. Third generation

	<b>Dark green prey</b>	<b>Medium green prey</b>	<b>Clear prey</b>
<b>Initial population</b>			
<b>Killed prey</b>			
<b>Surviving prey</b>			
<b>Next generation total number</b>			

Table 4. Fourth generation

	<b>Dark green prey</b>	<b>Medium green prey</b>	<b>Clear prey</b>
<b>Initial population</b>			
<b>Killed prey</b>			
<b>Surviving prey</b>			
<b>Next generation total number</b>			

Table 5. Fifth generation

	<b>Dark green prey</b>	<b>Medium green prey</b>	<b>Clear prey</b>
<b>Initial population</b>			
<b>Killed prey</b>			
<b>Surviving prey</b>			
<b>Next generation total number</b>			

Table 6. Sixth generation

	<b>Dark green prey</b>	<b>Medium green prey</b>	<b>Clear prey</b>
<b>Initial population</b>			
<b>Killed prey</b>			
<b>Surviving prey</b>			
<b>Next generation total number</b>			

Table 7. Seventh generation

	<b>Dark green prey</b>	<b>Medium green prey</b>	<b>Clear prey</b>
<b>Initial population</b>			
<b>Killed prey</b>			
<b>Surviving prey</b>			
<b>Next generation total number</b>			



## Part II - Mendelian Genetics

### INTRODUCTION:

Gregor Mendel discovered that many inherited physical traits are determined by a single pair of **alleles**, or alternative forms of the same **gene**. An allele may be **dominant**, where the characteristic is exhibited with a single copy, or **recessive**, where two copies of the same allele are required for the trait to be seen. A dominant allele is usually designated with a capital letter (A) and a recessive allele designated with a lower case letter (a). If both alleles for a trait are the same (both dominant or both recessive), the condition is called **homozygous**. If the alleles for a trait are different (one dominant and the other recessive), the condition is called **heterozygous**. This set of alleles belonging to an individual refers to an individual's **genotype**. The resulting set of traits that individuals show is called their **phenotype**.

### LABORATORY SET-UP:

For each trait, you will determine if you show the trait or not (phenotype), and then you will determine what your genetic make-up for that trait is (genotype). Next, determine whether each of your parents show the trait and what their genotypes are. Even if you don't know whether they show a particular trait, you may be able to figure it out based on your genotype. Set up some **Punnet squares** to help you do this. You can learn a lot about you and your family's genetic make-up through this exercise. If you don't feel comfortable examining your family history (if you were adopted or have estranged parents), an alternative family traits worksheet will be provided. You will then practice using the Punnet square to determine some hypothetical genetic family outcomes. Finally, you will get some additional practice using Punnet squares to set up **monohybrid** and **dihybrid** crosses.

### DISCRIPTIONS OF TRAITS:

1. **Widow's peak-** When the hairline dips down to a point in the center of the forehead. This is a dominant trait (W). A continuous hairline is recessive (w).



Widow's Peak

Photo from:  
<http://www.carteretcountyschools.org/staffdev/images/04/nov/sci/MVC-152F.JPG>

2. **Dimpled chin**- Depression or dimple in the chin is dominant (C). Its absence is recessive (c).
3. **Dimpled cheeks**- Presence of dimples in one or both cheeks is dominant (D). Absence is recessive (d).
4. **Rolling the Tongue into a "U"**- The ability to roll the tongue into a "U" is dominant (U). The inability to roll the tongue is recessive (u).
5. **Roman nose**- A high convex bridge (Roman nose) is dominant (R) and a flat or concave nose is recessive (r).

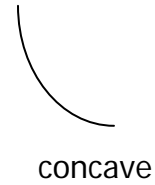
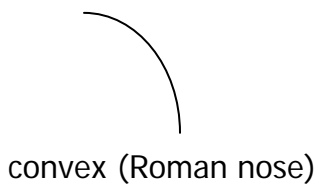


Photo from:

[http://www.whitehistory.com/refuting\\_rm/romans/aug01.jpg](http://www.whitehistory.com/refuting_rm/romans/aug01.jpg)

6. **Interlocking fingers**- When clasping your hands together, your left thumb on top is dominant (G). Right thumb on top is recessive (g).
7. **Double-jointed or hitchhikers thumb**- Loose ligaments are dominant (L), tight joints are recessive (l). Bend the distal joint of your thumb as far back as possible. The ability to touch your forearm is characteristic of this dominant trait.



Hitchhiker's thumb



Regular thumb

(Photos from: <http://www.ncrtec.org/tl/camp/gene/thumbs.htm>)

8. **Long palmer muscle**- Clench your fist and flex your hand. If there are three tendons in your wrist, you have the long palmer muscle. It is recessive (mm). If you show only two tendons, the large one will be missing, and you have the dominant allele (M).
9. **Attached ear lobes**- Free ear lobes are dominant (A), attached lobes are recessive (a).



Free Earlobes



Attached Earlobes

(Photos from:<http://www.jbhs.k12.nf.ca/biology/photos/jillear.jpg>)

10. **Bent little finger**- Lay your hands flat on the table with muscles relaxed. If the little finger bends in towards the ring finger, you have the dominant allele (F). Straight fingers are recessive (f).
11. **Pigmented irises**- The absence of pigment in the inner lining of the eye results in blue or gray eyes, a recessive trait (e). Brown, hazel or green eyes are dominant (E).
12. **Mid-digital finger hair**- If no hair is present on the middle or second segment of both your 3rd and 4th fingers, you are recessive (h). The presence of hair is dominant (H).
13. **Blaze**- A section of hair a different color from the rest is dominant (B). Lack of a blaze is recessive (b).



Singer Bonnie Raitt's hair blaze, the white section of hair in the middle of her forehead.

(Photo from: <http://www.thesoydailyclub.com/BiodieselBiobased/BR-BlueJacket-color.jpg>)

14. **Freckles**- Copious amounts of freckles are dominant (K). Plain skin is recessive (k).
15. **PTC taste**- The ability to taste phenylthiocarbamide (PTC) is dominant (P). Non tasters are recessive (p). Among the U.S. white population, tasters are 70% and non tasters are 30%. Approximately 90% of African-Americans are tasters. Your instructor will explain how to determine if you are a taster or not.
16. **Sodium Benzoate**- Tasters are dominant (S) and find it salty, bitter or sweet. Tasters tend to like sauerkraut, buttermilk and spinach. Non tasters are recessive (s). Your instructor will explain how to determine if you are a taster or not.
17. **Blood Type**- There are 4 blood types: A, B, AB and O. (Your Rh factor, or whether your blood is "positive" or "negative" is considered a different trait, i.e. a different gene.) The A, B and AB blood types are all dominant to O. Because more than one type is dominant the A, B and AB alleles distinguished by the capital letter (I) and a subtype ( $I^A$ ,  $I^B$ ,  $I^{AB}$ ), while the O allele is distinguished by a small letter (i).

Name: \_\_\_\_\_ Section: \_\_\_\_\_

Family History Worksheet

Trait	Your Phenotype (Do you have the trait?)	Your Genotype (AA, Aa or aa)	Mother's Phenotype	Mother's Genotype	Father's Phenotype	Father's Genotype
Widow's peak						
Dimpled chin						
Dimpled cheeks						
U-shaped tongue						
Roman nose						
Interlocking fingers						
Hitchhiker's thumb						
Long palmer						
Attached ear lobes						
Bent little finger						
Pigmented irises						
Mid-digital finger hair						
Blaze						
Freckles						
PTC taste						
Sodium benzoate						
Blood type						

Name: \_\_\_\_\_ Section: \_\_\_\_\_

Alternative Family Traits Worksheet

Trait	Your Phenotype (Do you have the trait?)	Your Genotype (AA, Aa or aa)	Mother's Phenotype	Mother's Genotype	Father's Phenotype	Father's Genotype
Widow's peak	No peak		No peak		No peak	
Dimpled chin	No dimpled chin		No dimpled chin		No dimpled chin	
Dimpled cheeks	No dimpled cheeks		No dimpled cheeks		No dimpled cheeks	
U-shaped tongue	Yes—can roll into U		Yes—can roll into U		No—can't roll into U	
Roman nose	No Roman nose		No Roman nose		No Roman nose	
Interlocking fingers	Left over right		Left over right		Left over right	
Hitchhiker's thumb	No hitchhiker's		No hitchhikers		No hitchhikers	
Long palmer	Yes—3 tendons		?		?	
Attached ear lobes	No—have free lobes		No—has free lobes		No—has free lobes	
Bent little finger	Yes—bent finger		Yes—bent finger		Yes-bent finger	
Pigmented irises	Yes—pigmented		Yes—pigmented		Yes—pigmented	
Mid-digital finger hair	No mid-digit hair		No mid-digit hair		No mid-digit hair	
Blaze	No blaze		No blaze		No blaze	
Freckles	No freckles		No freckles		No freckles	
PTC taste	Yes—can taste		?		?	
Sodium benzoate	Yes—can taste		?		?	
Blood type	Type O		Type O		Type A	