

## Pre-Lab Information

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**Purpose** Conduct an investigation to explore how the phenotypes within a population change over time.

**Time** Approximately 70 minutes

**Question** How does natural selection change the phenotypes within a population over time?

**Hypothesis** If the color of the light in the environment changes, then the population of the light red kidney beans will increase because the red light will make the light red kidney beans more difficult to see.

**Variables** *Independent Variable:* the color of the light in the environment  
*Dependent Variable:* the population of the light red kidney beans

**Summary** Your group will explore how phenotypes in a population change over time. This lab is based on a hypothetical scenario (see below) in which you will act as a predator, collecting one of two different colors of beans. Your job is to collect as many beans as you can in two minutes over the course of nine rounds. At the end of each round, the number of each color of bean will have changed. The group will need to repopulate the area based on the number of beans remaining. In three of the nine rounds, you will use red light pollution simulators. After all nine rounds, the group will graph the data to analyze changes in the bean populations.

**Scenario** Planet Oopsa is experiencing volcanic activity, and Mount Kaboom is set to erupt. A species of land animal named zocco roams the planet collecting walking beans. In this lab, you and your classmates will represent the zocco. There are two colors of kidney beans: light red and dark red. When Mount Kaboom erupts, red ash is thrown into the air, covering Oopsa and causing red light pollution. The zocco continue to collect any beans they can find. Eventually, the red dust settles back to the surface of Oopsa and the red light pollution goes away. What effect, if any, did the red light pollution have on the population of the beans?

## Safety

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- Wear clothing that is appropriate for working outside, including long pants, closed-toe shoes, and sunglasses.
- Be careful to avoid collisions with other students when using the red light pollution viewers.
- Ensure that behavior in the field is purposeful. Do not play with or eat any of the beans.
- Wash your hands thoroughly after handling all lab materials and making observations outside.
- Treat living organisms, such as the plants and insects you find outside, with respect and proper care.
- Report all accidents—no matter how big or small—to your teacher.

## Student Guide (continued)

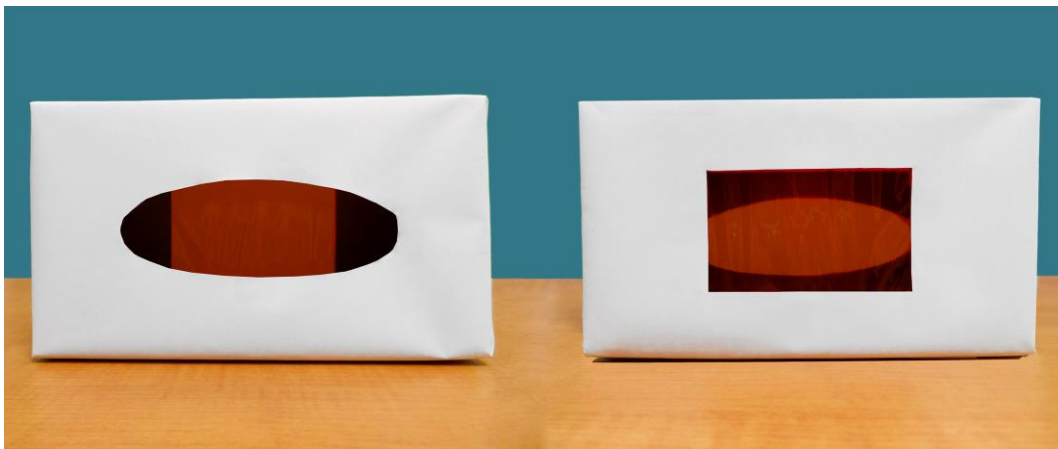
### Lab Procedure

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#### Step 1: Gather materials.

- String
- Scissors
- Scotch tape
- 4 plastic cups
- 10.5 in. paper plate with beveled lip
- 4 pencils
- Red cellophane
- 100 dark red kidney beans
- 100 light red kidney beans
- 4 empty rectangular tissue boxes

#### Step 2: Create red light pollution simulators.



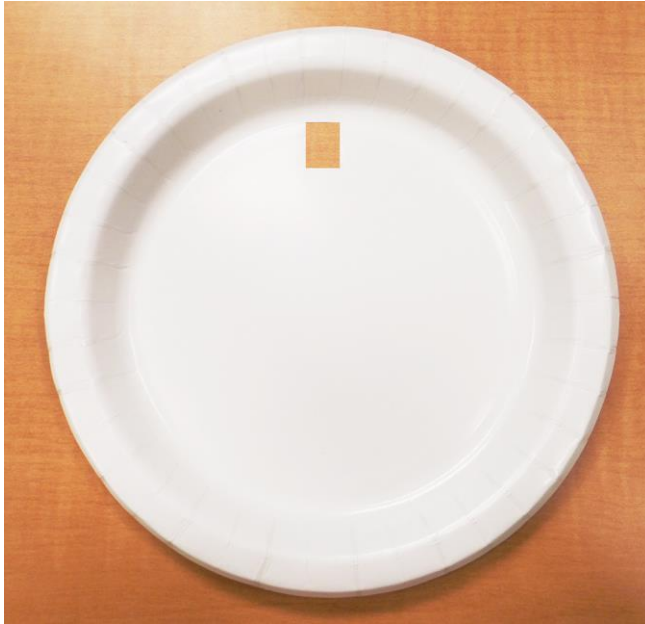
- a) Center and cut a 4" x 3" hole in the bottom of a tissue box.
- b) Cut a 5" x 4" piece of red cellophane to cover the hole you just cut.
- c) Place the cellophane over the hole.
- d) Tape the cellophane to all four corners of the tissue box with small pieces of tape. Try to keep the cellophane as flat as possible.
- e) Once the cellophane is held in place and flat, use longer pieces of tape to completely attach the cellophane to the tissue box.
- f) View objects by looking through the opening that is not covered in cellophane. If any clear cellophane is blocking this opening, remove it.
- g) Cut two pieces of string long enough to act as straps for the red light simulators. You will be fastening the string to the tissue box. Tie the strings behind your head to hold the tissue box to your eyes.
- h) Lay the viewer on the desk with the cellophane facedown toward the desk.
- i) Punch a small hole in the left side of the tissue box for the string to pass through. You can use the scissors to create the hole, but be careful not to make the hole too large.
- j) Push one of the pieces of string through the hole in the tissue box.
- k) Tie a knot in the string on the inside of the tissue box.
- l) Tape the knot to the inside of the tissue box.
- m) Tie a knot in the string on the outside of the tissue box to keep the string from falling into the box. The string should now be secured so it cannot be pulled in or out of the box.

## Student Guide (continued)

- n) Repeat the same process for the right side of the tissue box. You should now have two strings long enough to reach around and tie behind your head while you hold the viewer up to your eyes.

### Step 3: Create a bean sifter to help distribute the beans.

- a) Cut one  $\frac{1}{2}$ "  $\times$   $\frac{3}{4}$ " hole inside (and close to) the beveled edge of the paper plate. This will be the hole that the beans fall out of.



### Step 4: Set up your experimental area.

- a) Go to the center of your assigned collection area.  
b) Mix the light red and dark red kidney beans together on the bean sifter.  
c) Have one group member distribute the beans evenly over the entire area. To do this, you must walk in a spiral from the center of the area to the outer edge of your area. Slowly turn the plate in a circle as you walk to let the beans randomly fall out.

### Step 5: Perform the data collection for round 1.

- a) Once the whistle has been blown, begin the round by picking up one bean at a time and putting it in your cup.  
b) Continue collecting beans until the whistle is blown again two minutes later.  
c) Write your name and the names of your group members in the first column of Table A.  
d) Count the number of dark red kidney beans that each of you collected and record it in Table A, round 1. Do the same for the light red kidney beans.  
e) Add the number of all the dark red kidney beans collected by your group and enter it in the "Totals" box. Do the same for the light red kidney beans.

### Step 6: Repopulate the collection area for round 2.

- a) To repopulate the beans, you must use the "Totals" values from round 1. The number of dark red kidney beans to be replaced is equal to the total number of light red kidney beans that were collected. The number of light red kidney beans to be replaced will be equal to the total number of dark red kidney beans that were collected.

## Student Guide (continued)

- b) Gather the entire group's collected beans on the bean sifter. Give any extra beans to your teacher, or add beans to your population if needed.
- c) Mix the dark red and light red kidney beans together on the sifter.
- d) Have one group member distribute the beans evenly over the entire area. To do this, the group member must walk in a spiral from the center of the area to the outer edge of the area. The group member should slowly turn the plate in a circle while walking to let the beans randomly fall out.

**Step 7: Repeat Steps 5 and 6 two more times to fill in the data for Table A.**

**Step 8: Perform the data collection for round 4.**

- a) Hold your red light simulator over your eyes and tie the strings behind your head to hold the simulator in place. You will be using this for rounds 4, 5, and 6.
- b) Once the whistle has been blown to begin the round, pick up one bean at a time by hand and put it in your cup. No peeking.
- c) Continue collecting beans until the whistle is blown two minutes later.
- d) Remove your red light simulator.
- e) Write your name and the names of your group members in the first column of Table B.
- f) Count the number of dark red kidney beans that each of you collected and record it in Table B, round 4. Do the same for the light red kidney beans.
- g) Add the number of all the dark red kidney beans collected by your group and enter it in the "Totals" box. Do the same for the light red kidney beans.

**Step 9: Repopulate the collection area for round 5.**

- a) To repopulate the beans, you must use the "Totals" values from round 4. The number of dark red kidney beans to be replaced is equal to the total number of light red kidney beans that were collected. The number of light red kidney beans to be replaced is equal to the total number of dark red kidney beans that were collected.
- b) Gather the entire group's collected beans on the bean sifter. Give any extra beans to your teacher, or add beans to your population if needed.
- c) Mix the light red and dark red kidney beans together on the sifter and distribute them in a spiral pattern as you did before.

**Step 10: Repeat Steps 8 and 9 two more times to fill in the data for Table B.**

**Step 11: Perform the data collection for round 7.**

- a) Once the whistle has been blown, begin the round by picking up one bean at a time and putting it in your cup.
- b) Continue collecting beans until the whistle is blown again two minutes later.
- c) Write your name and the names of your group members in the first column of Table C.
- d) Count the number of dark red kidney beans that each of you collected and record it in Table C, round 7. Do the same for the light red kidney beans.
- e) Add the number of all the dark red kidney beans collected by your group and enter it in the "Totals" box. Do the same for the light red kidney beans.

## Student Guide (continued)

### Step 12: Repopulate the collection area for round 8.

- a) To repopulate the beans, you must use the “Totals” values from round 7. The number of dark red kidney beans to be replaced is equal to the total number of light red kidney beans that were collected. The number of light red kidney beans to be replaced will be equal to the total number of dark red kidney beans that were collected.
- b) Gather the entire group’s collected beans on the bean sifter. Give any extra beans to your teacher, or add beans to your population if needed.
- c) Mix the light red and dark red kidney beans together on the sifter and distribute them in a spiral pattern as you did before.

### Step 13: Repeat Steps 11 and 12 two more times to fill in the data for Table C.

### Step 14: Calculate the grand totals.

- a) Add the three total values for rounds 1–3 for the dark red kidney beans and enter them in Table D. Do the same for the light red kidney beans.
- b) Add the three total values for rounds 4–6 for the dark red kidney beans and enter them in Table D. Do the same for the light red kidney beans.
- c) Add the three total values for rounds 7–9 for the dark red kidney beans and enter them in Table D. Do the same for the light red kidney beans.

### Step 15: Calculate the mean number of beans collected per three-round period.

- a) Divide the total number of dark red kidney beans found in Table D (for rounds 1–3) by 3 to get the mean, or average. Enter the mean for the dark red kidney beans in Table E. Repeat this process for the light red kidney beans.
- b) Divide the total number of dark red kidney beans found in Table D (for rounds 4–6) by 3 to get the mean, or average. Enter the mean for the dark red kidney beans in Table E. Repeat this process for the light red kidney beans.
- c) Divide the total number of dark red kidney beans found in Table D (for rounds 7–9) by 3 to get the mean, or average. Enter the mean for the dark red kidney beans in Table E. Repeat this process for the light red kidney beans.

### Step 16: Graph your results to examine how the bean populations changed over time.

- a) Follow these directions to construct graphs of your data. Sketch your graphs in Section 2 of your Lab Report Guide. Each person in the group should have a graph of the group’s data.
- b) Label the  $x$ -axis as the number of rounds.
- c) Label the  $y$ -axis as the number of beans collected.
- d) Graph the total number of dark red kidney beans collected for each of the nine rounds.
- e) Draw a line connecting the dots.
- f) On the same graph, plot the total number of light red kidney beans collected for each of the nine rounds.
- g) Use a different color to draw a line connecting all of the data for the light red kidney beans.

## Student Guide (continued)

### Step 17: Graph your results from the mean number of beans collected per three-round period.

- a) Follow these directions to construct graphs of your mean data. Sketch your graphs in Section 2 of your Lab Report Guide. Each person in the group should have a graph of the group's data.
- b) Label the  $x$ -axis as the number of rounds.
- c) Label the  $y$ -axis as the number of beans collected.
- d) Graph the mean number of dark red kidney beans collected.
- e) Draw a line connecting the dots.
- f) On the same graph, plot the mean number of light red kidney beans collected.
- g) Use a different color to draw a line connecting all of the data for the light red kidney beans.

### Step 18: Clean up the lab.

- a) Collect the beans and return them to your teacher.
- b) Save the red light pollution simulators for another day.

## Student Guide (continued)

### Data

Record your data either in your lab notebook or in the tables below.

**Table A**

No Pollution	Round 1		Round 2		Round 3	
Student name	Dark red kidney beans	Light red kidney beans	Dark red kidney beans	Light red kidney beans	Dark red kidney beans	Light red kidney beans
Totals						

**Table B**

Red Light Pollution	Round 4		Round 5		Round 6	
Student name	Dark red kidney beans	Light red kidney beans	Dark red kidney beans	Light red kidney beans	Dark red kidney beans	Light red kidney beans
Totals						

**Table C**

No Pollution	Round 7		Round 8		Round 9	
Student name	Dark red kidney beans	Light red kidney beans	Dark red kidney beans	Light red kidney beans	Dark red kidney beans	Light red kidney beans
Totals						

## Student Guide (continued)

Table D

Summation Table	Rounds 1–3		Rounds 4–6		Rounds 7–9	
	Dark red kidney beans	Light red kidney beans	Dark red kidney beans	Light red kidney beans	Dark red kidney beans	Light red kidney beans
Grand Totals						

Table E

Mean Table	Rounds 1–3		Rounds 4–6		Rounds 7–9	
	Dark red kidney beans	Light red kidney beans	Dark red kidney beans	Light red kidney beans	Dark red kidney beans	Light red kidney beans
Mean Values						

### Follow-Up Questions

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Answer the following questions.

1. What do you think would have happened if the light pollution had been a permanent condition on planet Oopsa?
  
  
  
  
  
  
  
  
  
  
2. What do you think would have happened if the light pollution were green instead of red?