**Your name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Full names of your group members:**



**As usual, e*ach group member MUST SUBMIT THEIR OWN WORK IN THEIR OWN WORDS, unless otherwise stated by the question. If sentence guidelines are not given, assume 1—2 sentences.***

**Introductory Questions**

For the questions in this section *and this section alone*, all group members may use the same wording.

1. Record 2—3 different observations about the behavior of your population of dots below. *For this question*, all group members may use the same wording.
2. Explain why the “starting population” and the “current population” bar plots are the same or different. In your answer, you must consider whether any evolution took place between the starting and current populations. (2-3 sentences)
3. Explain why the bar plots before and after predation are the same or different. In your answer, you must consider whether any evolution took place during the predation. (2-3 sentences)
4. Explain why the bar plots before and after reproduction are the same or different. In your answer, you must consider whether any evolution took place during reproduction. (2-3 sentences)

**Exercise #1 Questions: Variable speed, heritable speed variation, and selective survival**

1. What are your alternative and null hypotheses for how the population of dots will look (in terms of distribution of dot speeds) after 5 generations?
2. Complete the table below with your results:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Generation | Predation | ← Slower Faster → | | | | | | |
| 1 (Black) | 2 (Purple) | 3 (Blue) | 4 (Green) | 5 (Yellow) | 6 (Orange) | 7 (Red) |
| 1 | Before |  |  |  |  |  |  |  |
|  | After |  |  |  |  |  |  |  |
| 2 | Before |  |  |  |  |  |  |  |
|  | After |  |  |  |  |  |  |  |
| 3 | Before |  |  |  |  |  |  |  |
|  | After |  |  |  |  |  |  |  |
| 4 | Before |  |  |  |  |  |  |  |
|  | After |  |  |  |  |  |  |  |
| 5 | Before |  |  |  |  |  |  |  |
|  | After |  |  |  |  |  |  |  |

1. How, if at all, did the dot population change over time? Do these results support your hypothesis, or do they fail to support your hypothesis?
2. What do you predict the population of dots would look like after 50 generations of predation (instead of 5), under this exercise’s conditions?
3. Do you conclude that the population of dots evolved? Why or why not?
4. Do you conclude that natural selection specifically acted on the dot population? Why or why not?

**Exercise #2 Questions: NO Variable speed, heritable speed variation, and selective survival**

1. What are your alternative and null hypotheses for how the population of dots will look (in terms of distribution of dot speeds) after 5 generations?
2. Complete the table below with your results:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Generation | Predation | ← Slower Faster → | | | | | | |
| 1 (Black) | 2 (Purple) | 3 (Blue) | 4 (Green) | 5 (Yellow) | 6 (Orange) | 7 (Red) |
| 1 | Before |  |  |  |  |  |  |  |
|  | After |  |  |  |  |  |  |  |
| 2 | Before |  |  |  |  |  |  |  |
|  | After |  |  |  |  |  |  |  |
| 3 | Before |  |  |  |  |  |  |  |
|  | After |  |  |  |  |  |  |  |
| 4 | Before |  |  |  |  |  |  |  |
|  | After |  |  |  |  |  |  |  |
| 5 | Before |  |  |  |  |  |  |  |
|  | After |  |  |  |  |  |  |  |

1. How, if at all, did the dot population change over time? Do these results support your hypothesis, or do they fail to support your hypothesis?
2. What do you predict the population of dots would look like after 50 generations of predation (instead of 5), under this exercise’s conditions?
3. Do you conclude that the population of dots evolved? Why or why not?
4. Do you conclude that natural selection specifically acted on the dot population? Why or why not?

**Exercise #3 Questions: Variable speed, NO heritable speed variation, and selective survival**

1. What are your alternative and null hypotheses for how the population of dots will look (in terms of distribution of dot speeds) after 5 generations?
2. Complete the table below with your results:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Generation | Predation | ← Slower Faster → | | | | | | |
| 1 (Black) | 2 (Purple) | 3 (Blue) | 4 (Green) | 5 (Yellow) | 6 (Orange) | 7 (Red) |
| 1 | Before |  |  |  |  |  |  |  |
|  | After |  |  |  |  |  |  |  |
| 2 | Before |  |  |  |  |  |  |  |
|  | After |  |  |  |  |  |  |  |
| 3 | Before |  |  |  |  |  |  |  |
|  | After |  |  |  |  |  |  |  |
| 4 | Before |  |  |  |  |  |  |  |
|  | After |  |  |  |  |  |  |  |
| 5 | Before |  |  |  |  |  |  |  |
|  | After |  |  |  |  |  |  |  |

1. How, if at all, did the dot population change over time? Do these results support your hypothesis, or do they fail to support your hypothesis?
2. What do you predict the population of dots would look like after 50 generations of predation (instead of 5), under this exercise’s conditions?
3. Do you conclude that the population of dots evolved? Why or why not?
4. Do you conclude that natural selection specifically acted on the dot population? Why or why not?

**Exercise #4 Questions: Variable speed, heritable speed variation, and NO selective survival**

1. What are your alternative and null hypotheses for how the population of dots will look (in terms of distribution of dot speeds) after 5 generations?
2. Complete the table below with your results:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Generation | Predation | ← Slower Faster → | | | | | | |
| 1 (Black) | 2 (Purple) | 3 (Blue) | 4 (Green) | 5 (Yellow) | 6 (Orange) | 7 (Red) |
| 1 | Before |  |  |  |  |  |  |  |
|  | After |  |  |  |  |  |  |  |
| 2 | Before |  |  |  |  |  |  |  |
|  | After |  |  |  |  |  |  |  |
| 3 | Before |  |  |  |  |  |  |  |
|  | After |  |  |  |  |  |  |  |
| 4 | Before |  |  |  |  |  |  |  |
|  | After |  |  |  |  |  |  |  |
| 5 | Before |  |  |  |  |  |  |  |
|  | After |  |  |  |  |  |  |  |

1. How, if at all, did the dot population change over time? Do these results support your hypothesis, or do they fail to support your hypothesis?
2. What do you predict the population of dots would look like after 50 generations of predation (instead of 5), under this exercise’s conditions?
3. Do you conclude that the population of dots evolved? Why or why not?
4. Do you conclude that natural selection specifically acted on the dot population? Why or why not?

**Exercise #5 Questions: Variable size, heritable size variation, and selective survival**

1. What are your alternative and null hypotheses for how the population of dots will look (in terms of distribution of dot sizes) after 5 generations?
2. Complete the table below with your results:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Generation | Predation | ← Slower Faster → | | | | | | |
| 1 (Black) | 2 (Purple) | 3 (Blue) | 4 (Green) | 5 (Yellow) | 6 (Orange) | 7 (Red) |
| 1 | Before |  |  |  |  |  |  |  |
|  | After |  |  |  |  |  |  |  |
| 2 | Before |  |  |  |  |  |  |  |
|  | After |  |  |  |  |  |  |  |
| 3 | Before |  |  |  |  |  |  |  |
|  | After |  |  |  |  |  |  |  |
| 4 | Before |  |  |  |  |  |  |  |
|  | After |  |  |  |  |  |  |  |
| 5 | Before |  |  |  |  |  |  |  |
|  | After |  |  |  |  |  |  |  |

1. How, if at all, did the dot population change over time? Do these results support your hypothesis, or do they fail to support your hypothesis?
2. What do you predict the population of dots would look like after 50 generations of predation (instead of 5), under this exercise’s conditions?
3. Do you conclude that the population of dots evolved? Why or why not?
4. Do you conclude that natural selection specifically acted on the dot population? Why or why not?

**Final Questions**

1. Based on your overall results, do you conclude that is it possible to have evolution occur without natural selection? Is it possible to have natural selection occur without evolution? Explain your reasoning in 2—4 sentences.
2. Based on your overall results, what do you conclude are the roles of variation and heritability in natural selection? In evolution more generally? Explain your reasoning in 3—5 sentences.
3. In this program, individual dots never change their speed (or size). Given that individual dots never vary in their lifetime, how is it possible that the dot population could have evolved? Explain your reasoning in 2—3 sentences.
4. What role did predation (i.e., you clicking the dots) have in causing the population to evolve? In other words, do you expect the population would have evolved without any predators? Why or why not? Explain your reasoning in 3—5 sentences.