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

**Survivor: Extreme Environments (Student Edition)**

*Part 1: Adaptation leads to Evolution*

Introduction:

Organisms have many traits that help them to survive and adapt to their environment. These traits can be physical and easy for us to see like height, or they can be molecular traits which need to be tested for in a lab, like being faster than average at processing sugar. For the exercise, we’re going to focus on the physical traits of coloration, size and shape, but ANY trait could be selected for in the same basic ways.

Student Objectives: At the conclusion of these lessons, you will be able to:

* Explain the role of the environment in natural selection and evolution
* Explain how variants lead to evolution through natural selection
* Explain how invasive species create competition with native species
* Explain how invasive species can affect natural selection and evolution

Pre-Lab Observations

1. Describe some of the variation observations you saw while outside. Describe how each variation could help the organism survive and reproduce.

|  |  |  |
| --- | --- | --- |
| Variant  | Observations of characteristics / adaptations. | Possible advantages due to characteristics / adaptations. |
| 1 | *
*
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*
 |
| 2 | *
*
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 | *
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1. Now, pick two different seeds and compare and contrast them.

|  |  |  |
| --- | --- | --- |
|  | Observations of characteristics / adaptations. | Possible advantages due to characteristics / adaptations. |
| 1 | *
*
*
*
 | *
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*
 |
| 2 | *
*
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 | *
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1. Describe your ecosystem.
2. Describe your seed population.

Experiment:

You have an ecosystem that can support 40 seeds each generation. Your group will distribute the seeds within your ecosystem, and then perform 3 rounds of selection to see which seeds are best adapted.

Prediction:

 Which seed do you think will be best adapted to your ecosystem? Which of its traits do you think will be adaptive? Is that trait exactly the same in all the seeds or do they vary?

Procedures:

1. Please check that you have 40 seeds in your seed population (10 each of 4 different types of seeds).
2. Have one student randomly sprinkle the seed population in your ecosystem.
3. When the teacher instructs you, have another student pick 20 seeds in 60 seconds. Be sure to choose randomly by looking away between each seed and grabbing the first one that you can find. Put all these seeds in your Selected Against 1 bin.
4. When done, count up the seeds you have collected and use the data table #1.
5. Calculate the number of seeds remaining in your environment by subtracting from the starting population. Rotate jobs.
6. For generations 2 & 3, double the amount of the remaining of each type of seeds (for example, if you pulled out 3 seed2 in generation #1, 7 still remain in the ecosystem. You will need to add 7 new seeds to get to a total of 14 for generation #2).
7. As a team, find all the remaining seeds and put them in your Survivor bin

Post Lab Analysis.

1. Which seed (or seeds) did the best in your ecosystem? Was the best seed for your ecosystem the one you thought it would be?
2. Compare the seeds that survived to the ones that didn’t. What do the survivors have in common? Was there more than one way to survive?
3. Make a claim about how adaptation can change the variation within a population based on the ecosystem. Be sure to support your claim with data from this lab.

Claim:

Evidence supporting:

1. Compare and contrast your data to the other ecosystems. Explain why your data is similar to or different from the other ecosystems. Was there one seed that was best everywhere (a generalist)? Or were some seeds only good in one or two ecosystems (specialists)?

Critical Thinking

1. What has happened to the amount of variation in your surviving population? If you kept selecting in this way for hundreds of generations, what would you expect to happen? What other processes might change this result?

*Part 2: Invasive species*

There are lots of ways to be an invasive plant, and although scientists have been trying to figure out what they all have in common for over 50 years, we still don’t have a good answer. However, many invasive plant species do reproduce more quickly and with many more seeds.

Pre-lab questions

1. What is an invasive species? Are they common?
2. Although we hear about invasive species all the time, relatively few species actually are invasive. Only about 1 in every 1,000 species that could be an invasive species actually ends up an as one. What conditions might make it difficult for a non-native species to establish itself in a new ecosystem?

Experiment:

You again have an ecosystem, however, one of your species now reproduces *twice as fast* as the others. Your group will distribute the seeds within your ecosystem, and then perform 3 rounds of selection to see which seeds are best adapted. However, one of your species now reproduces twice as fast as the others.

Predictions:

If the reproductive rates change for your seeds (for example, instead of doubling – it triples or quadruples each generation), how would the population change over time?

Your invasive seed can reproduce twice as fast as the other seeds; do you think that it will be able to successfully invade your environment? Why or why not?

Procedures:

1. Please check that you have 40 seeds in your seed population (10 each 4 different types of seeds).
2. Have one student randomly sprinkle the seed population in your ecosystem.
3. When the teacher instructs you, have another student pick 20 seeds in 60 seconds. Be sure to choose randomly by looking away between each seed and grabbing the first one that you can find.
4. When done, count up the seeds you have collected and use the data table #1.
5. Calculate the number of seeds remaining in your environment by subtracting from the starting population.
6. For generations 2 & 3, multiply the amount of the remaining of each of your native seeds by 2 (for example, if you pulled out 3 seed3 seeds in generation #1, 7 still remain in the ecosystem. You will need to add 7 to get to 14 for generation #2).
7. For your invasive species in generations 2 & 3, triple the amount of remaining seed (for example, if you pulled out 3 invasive species seeds in generation #1, 7 still remain in the ecosystem. You will need to add 14 seeds to get to 21 for generation #2).

Post Lab Analysis.

1. Compare your results with those of other ecosystems. Was the invasive equally successful in all ecosystems? Why or why not?
2. Make a claim about how reproductive rates along with adaptation can alter biodiversity within an ecosystem. Be sure to support your claim with data from this lab.

Claim:

Evidence supporting:

1. Compare and contrast your data to the other ecosystems. Explain why you have similar or different data for each other ecosystem.
2. Another way to be an invasive plant is to grow in a place where you have few or no predators. If we replaced one of your seed types with seeds covered in painful spines, how would it affect the diversity of your ecosystem?
3. Radish has become an invasive weed by flowering much earlier than its ancestors. How could flowering earlier let you become invasive?

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| --- | --- | --- | --- | --- | --- |
| Population | Starting # | Seeds Collected | Seeds Remaining(A) | Seeds Remaining times 2 (B) | Seeds Needed:B – A =  |
| Seed1 | 10 |  |  |  |  |
| Seed2 | 10 |  |  |  |  |
| Seed3 | 10 |  |  |  |  |
| Seed4 | 10 |  |  |  |  |

**First Generation**

Experiment 1

Environment: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Population | Starting # | Seeds Collected | Seeds Remaining(A) | Seeds Remaining times 2 (B) | Seeds Needed:B – A = |
| Seed1 |  |  |  |  |  |
| Seed2 |  |  |  |  |  |
| Seed3 |  |  |  |  |  |
| Seed4 |  |  |  |  |  |

**Second Generation**

|  |  |  |  |
| --- | --- | --- | --- |
| Population | Starting # | Seeds Collected | Seeds Remaining |
| Seed1 |  |  |  |
| Seed2 |  |  |  |
| Seed3 |  |  |  |
| Seed4 |  |  |  |

**Third Generation**

**Title: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**



Key

* Seed1
* Seed2
* Seed3
* Seed4

 **First Generation**

Experiment 2

Environment: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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| --- | --- | --- | --- | --- | --- | --- |
| Population | Starting # | Seeds Collected | Seeds Remaining(A) | Seeds Remaining times 2 (B) | Seeds Remaining times 3 (C) | Seeds Needed: |
| Seed5 | 10 |  |  |  |  | C – A =  |
| Seed2 | 10 |  |  |  |  | B – A = |
| Seed3 | 10 |  |  |  |  | B – A = |
| Seed4 | 10 |  |  |  |  | B – A = |

**Second Generation**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Population | Starting # | Seeds Collected | Seeds Remaining(A) | Seeds Remaining times 2 (B) | Seeds Remaining times 3 (C) | Seeds Needed: |
| Seed5 |  |  |  |  |  | C – A =  |
| Seed2 |  |  |  |  |  | B – A = |
| Seed3 |  |  |  |  |  | B – A = |
| Seed4 |  |  |  |  |  | B – A = |

**Third Generation**

|  |  |  |  |
| --- | --- | --- | --- |
| Population | Starting # | Seeds Collected | Seeds Remaining |
| Seed5 |  |  |  |
| Seed2 |  |  |  |
| Seed3 |  |  |  |
| Seed4 |  |  |  |

**Title: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**



Key

* Invasive Seed5
* Seed2
* Seed3
* Seed4