Activity 4: Changes in the Environment

In this activity, students explore how natural environmental changes affect the survival of populations of plants. Students compare rapid and slow changes in an environment and the effect of these changes on the population of plants. This activity builds on the knowledge that variations in offspring play an important role in the survivability of the species. Students are also introduced to two very important concepts: extinction and common ancestry. These concepts are key to understanding how changes occur over many generations.

Learning Goals

Learning goals highlighted in blue may be new to students as they have not been covered in prior computer activities.

Big Idea 3: Organisms and Their Environment

- Selection based on water or sunlight could lead a population (not an individual) of plants to migrate from one area to another.

Big Idea 7: Intraspecific differences

- Not all offspring from the same parents look alike, even with respect to inherited traits.

Big Idea 8: Adaptation/Evolution

- Species are adapted to their environments and species adapt to changes in their environment. If the environment changes only certain species survive.
- Selection pressure could lead to a change in the characteristics of a population.
- Adaptation requires both variability and selection pressure.

Big Idea 11: Descent with modification

- Species evolve from common ancestors.
- Different species can arise from one species if different groups have different selection pressures.

The Virtual Field Model

In this activity, students use a model (page 2) of a Virtual Field with a “medium” sunlight level that best supports Plant Size 5. Students are encouraged to notice that these plants have variation in their offspring (Leaf Size 4 and Leaf Size 6), but that those varieties of plants grow and wilt. They do not produce flowers and, therefore, do not produce offspring with similar traits. The key to understanding that the plants are different is to use the Information Tool  .

Students also use a model (page 4) of a field in which they can speed up time and observe the growth of a "Virtual Mountain Range." The goal of the model is to have your students explore how slow versus

rapid changes in the environment affect the population of plants over time. In this model students can introduce a mountain range by clicking on the radio buttons for "Mountain height" to the right of the model. If the mountain range rises too quickly, the plants will go extinct. If the mountains form slowly, the population of plants will evolve. **Students should have a chance to explore both conditions.**

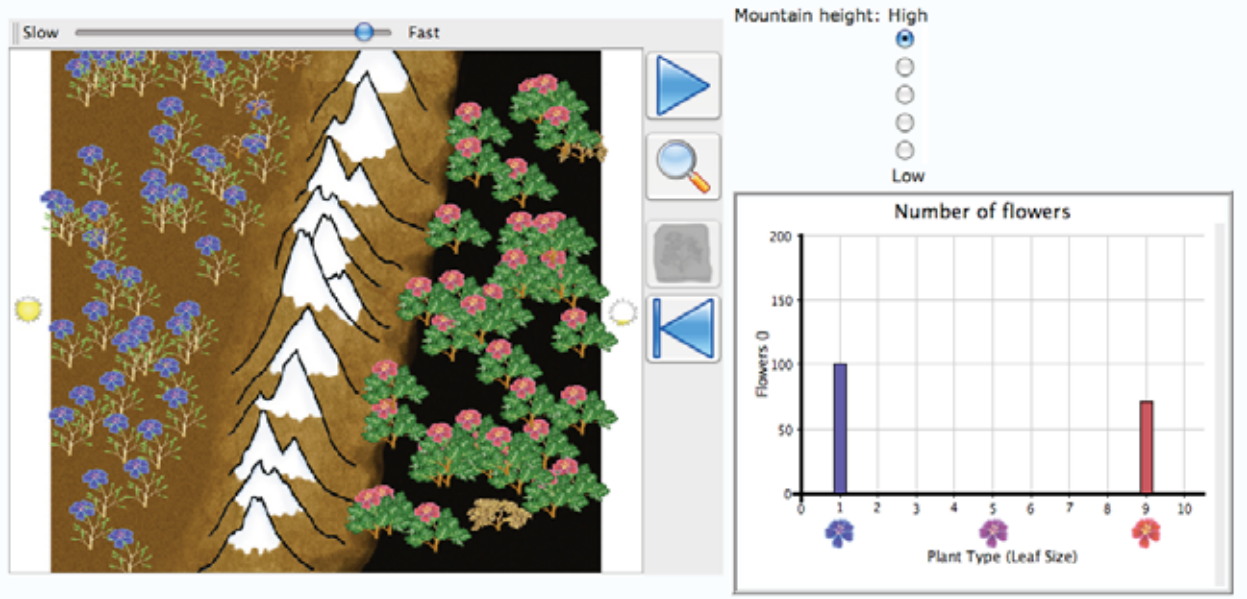


Figure 1 (left) is the Virtual Field with a tall mountain range in the middle. The radio buttons to the right of the model allow students to change the mountain height. The graph shows the number of healthy (flowering) plants. Students can use the Information Tool to compare plant *leaf size on either side of the mountains and reinforce what they see in the graph. Note: The plant button in these models scatters several seeds rather than just one seed as in the previous models.*

The graph is key to understanding how the population is changing. When students start the model there is one line on the graph (Leaf Size 5). As the model runs and students change the height of the mountains, the population of plants will go extinct (if the mountain change is fast) or there will be a change in the population of the plants as they adapt to the new environment (if the mountain change is slow). Spend time as a class interpreting the graph.

Model buttons

Make sure you run the model before your students start this activity to ensure that you are familiar with the model and the control buttons. Below are descriptions of the control buttons.

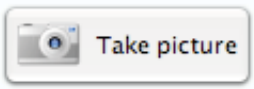
Review the use of these buttons with your students before they run the activity.

Click the Play button to start the model. Use the Pause button to stop it.

Click the Information Tool and then click on a plant in the model for information about the plant.

Click the seed packet icon to scatter several seeds at once.

Click the Reset button to reset the model to its original condition.



Click the Take picture button to take a picture of the model. (Note: when you take a picture, the model pauses. You must click Play to restart it.) You can annotate your picture.

The Lab Book holds all pictures.

The glossary contains definitions for the vocabulary words used in this activity.

Lesson Plan

1. Estimated time

This activity should take approximately 45 minutes.

2. Introduce the activity (Engage)

Lead a brief class discussion before running the activity.

Review with students how variations in the offspring could account for changes in the population of a species over time.

- How do changes in the environment affect how plants and animals survive?
- How might variation in offspring help the babies to survive in different environments than their parents?
- How do seeds end up in the environment that they thrive in?
- How does the environment relate to how the population changes over time?

While conducting this discussion it is important to listen for language that indicates students are describing the variations in the offspring and how those variations are better adapted to the environment. This is the foundation of natural selection. Be sure to note that individual plants do not change (or adapt) to better "fit" the environment and they do not pass on any acquired traits. Rather, variation in inherited traits passed down to their offspring helps the population adapt over a long time.

As students run the activity you may want them to keep the following discovery question in their minds. Write this question on the board so that students can see it during the class period.

What is a common ancestor?

3. Guided inquiry (Explore)

Have students run the activity.

Refer to the stop sign symbols 

in the following section. Stop on those activity pages and lead a full-class discussion.

If students are working in pairs or small groups, explain to them that they should discuss their answers with classmates, and then type their answers directly into the computer.

Page 1
No questions.

Page 2
No questions.

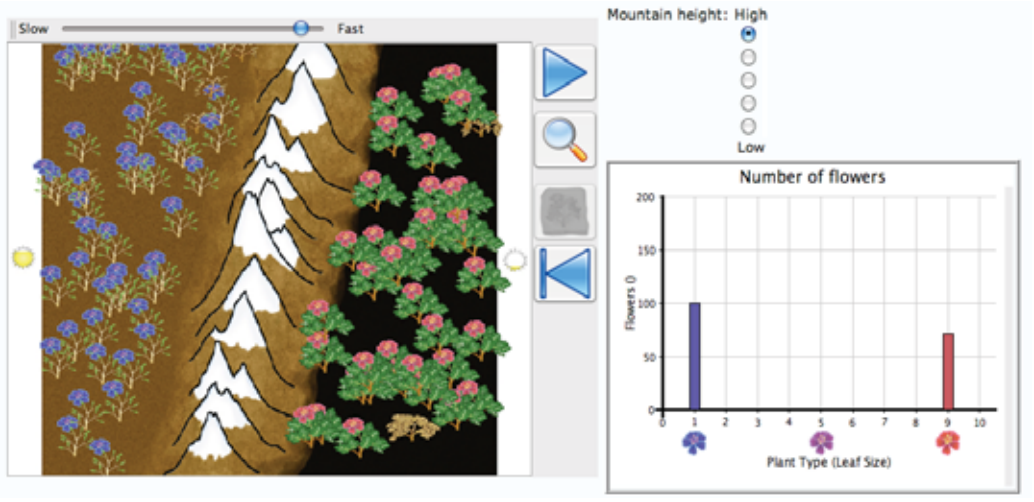
It is important for students to notice that in this field with "medium" sunlight level, Leaf Size 5 plants grow best, which means they produce flowers and new seeds. All offspring inherit traits from the parent plants, but because of natural variation, some of the offspring will also grow well and flower (Leaf Size 5) while some will be a little different and grow to be brown and wilted (Leaf Sizes 4 and 6).

Page 3

Q1. Why did some plants have flowers while others were brown and wilted?
A. Student answers will vary. Most plants are Leaf Size 5, which grow best in the "medium" sunlight environment. Because of natural variation in the offspring, some plants are Leaf Size 4 and some are Leaf Size 6. These grow up brown and wilted because the environment does not match their needs.

Q2. If the environment became shadier, which plant would grow better?
A. Offspring with slightly larger leaves (Leaf Size 6)

Page 4
No questions.



Student pictures will vary. Field with high mountains with flowers on both sides. Notice that there is still variation in the plants. Some plants grow up to be brown and wilted.

Ask students if they were able to get flowers to grow on both sides of the mountains. If so, how? Discuss the time it would take for this kind of adaptation to happen. A population of plants needs time for the variations to grow up and produce enough offspring of their own with similar traits that "fit" the environment.

Page 5

Q3. What happened to the environment on each side of the mountain as the mountains grew taller?
A. One side of the mountains became more sunny and the other side became more shady.

Q4. Which plants grow best on side A?
A. Leaf Size 1 Plants

Q5. Which plants grow best on side B?
A. Leaf Size 9 Plants.

Page 6

Q6. What happened to the population of plants as the environment changed slowly?
A. Some offspring that were different than their parents were able to survive in the new environment.

Q7. What happened to the plants when the mountains grew quickly?
A. Student answers will vary. The plants did not survive. The environment changed too quickly for the plant population to adapt.

Page 7

Q8. In Graph 1, how many types of plants are there?
A. 1

Q9. In Graph 2, how many types of plants are there?
A. 2

Q10. In Graph 4, are there more Leaf Size 2 plants or Leaf Size 8 plants?
A. More Leaf Size 8

Q11. Look at all four graphs above. Tell a story to describe what happened to the plants when the mountains formed and the environment changed.
A. Student answers will vary. Students should describe the original plant (Leaf Size 5) in the field environment in Graph 1. In Graph 2, mountains were formed with an accompanying change on each side, so that different plants were selected for (Leaf Sizes 4 and 6). The following graphs (Graph 3 and Graph 4) show that the environments favored different plants, eventually quite different than the original Leaf Size 5 common ancestor plant.

Page 8

Q12. Why did the Leaf Size 5 plant go extinct?
A. The environment had the wrong level of sunlight for the Leaf Size 5 plant.

Page 9

Q13. Why do you think manatees have toenails on their flippers?
A. Because they evolved from an ancestor that had toenails.

Page 10
No questions

Wrap up the activity with the discussion below.

4. Discuss the activity (Explain)

After students run this activity, discuss what students concluded from the activity. In particular, it is important to discuss the discovery question with your students:

What is a common ancestor?

In addition, you might like to discuss the effects of rapid versus slow environmental changes on a population.

Common ancestry

In the model, after the mountains were formed, Leaf Type 1 and Leaf Type 9 plants were growing on either side of the mountain. What Leaf Type was the common ancestor? (Answer: Leaf Type 5) What happened to the plant type you started with? (Answer: the Leaf Size 5 plant went extinct because the environment no longer supports its growth.)

Where did the new plant varieties come from? (Answer: The new varieties of plants came from variations in the original plant.)

Why do we say that the new plants share a common ancestor? (Answer: The new plants share a common ancestor because they both evolved from the same type of plant over many, many generations based on changes in the environment.)

Below are suggestions for additional discussion questions:

Rapid versus slow changes to environment

What happens to the plant population immediately after an environmental change? (Answer: Most or all of the plants die. Some of the offspring with different variations may be able to live under the new environmental conditions. However, if the environment changes too quickly for the plants with favored traits to survive and reproduce, they will not be able to pass these traits down. If a population's size gets to be too small, it is difficult for it to recover.)

What environmental changes happened and how does this help explain what happened to the plants? (Answer: When the mountain height changed, the environment changed on either side. In particular, the amount of sunlight on each side of the mountain range changed. Some plant offspring with different leaf sizes were able to live, but most of the plants died.)

What happens to the plant population when you change the mountain height quickly compared to when you change it slowly? (Answer: When the mountain height changes quickly, the plant population does not have time to adapt: it goes extinct. When the mountain height changes slowly, the plant population adapts. With a slow change, slight variation in offspring can give a small number of individuals within a population the ability to survive. These offspring that are adapted to live in the new environment also need time to grow and drop seeds that carry their traits. As the populations continue to adapt, the varieties may be sufficiently different from one another that they are effectively different species. But note that we do not specifically define species in this activity.)