Activity 5: The Mystery Plants Mystery

This activity is designed to be an assessment to determine whether or not students can transfer the knowledge they have acquired about the Mystery Plants to a new adaptation—roots. Thus, it is also a review. Again, students are asked to determine where plants grow best in the Virtual Greenhouse flower boxes. This activity reinforces the concept that there is variation in the offspring of individuals of the same species. Students examine the offspring of the Mystery Plants and how variations in the offspring's roots are related to the plant's need for water. In the final model, students plant seeds of one plant type in the Virtual Field and observe how populations of plants can adapt to new environments over many, many generations.

Learning Goals

Big Idea 3: Organisms and Their Environment

- An organism thrives in specific environments that match its specific needs.
- Selection based on water or sunlight would lead a population (not an individual) of plants to migrate from one area to another.

Big Idea 7: Intraspecific Differences

- Individuals of the same species may differ.
- 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.
- Organisms with traits best suited to their environment have better chances of survival.

The Virtual Greenhouse Model

In this activity, students use the "Virtual Greenhouse" model (page 2). In the Virtual Greenhouse there are five flower boxes that each receive different amounts of water. Students can plant three different varieties of plants—labeled X, Y, and Z. Each plant is uniquely adapted to grow best in soil containing a certain amount of water. The goal of the model is to have students experiment by planting seeds in the flower boxes and determining where each plant type grows best. A healthy plant will grow and produce a flower. An unhealthy plant will wilt or die.

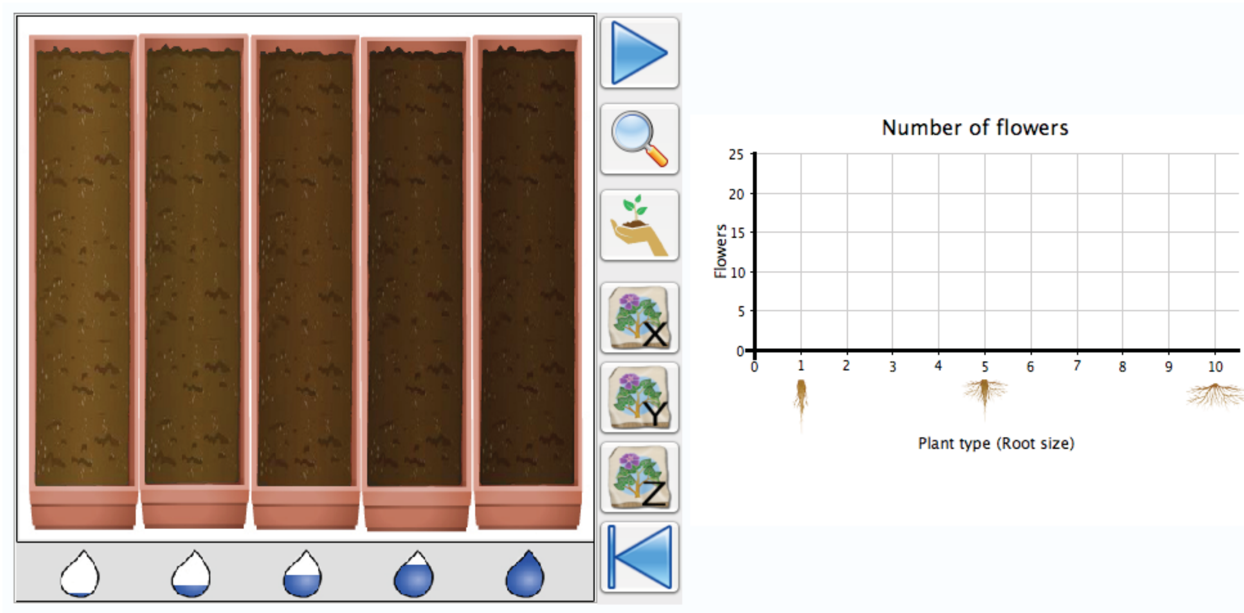


Figure 1. The Virtual Greenhouse. The water drop icons on the bottom show how much water each flower box receives. The buttons on the right control the model. The seed buttons are labeled X, Y, and Z to represent three plants that look the same (same leaf size, same flower color), but have different root sizes. The graph shows the number of healthy (flowering) plants of each type.

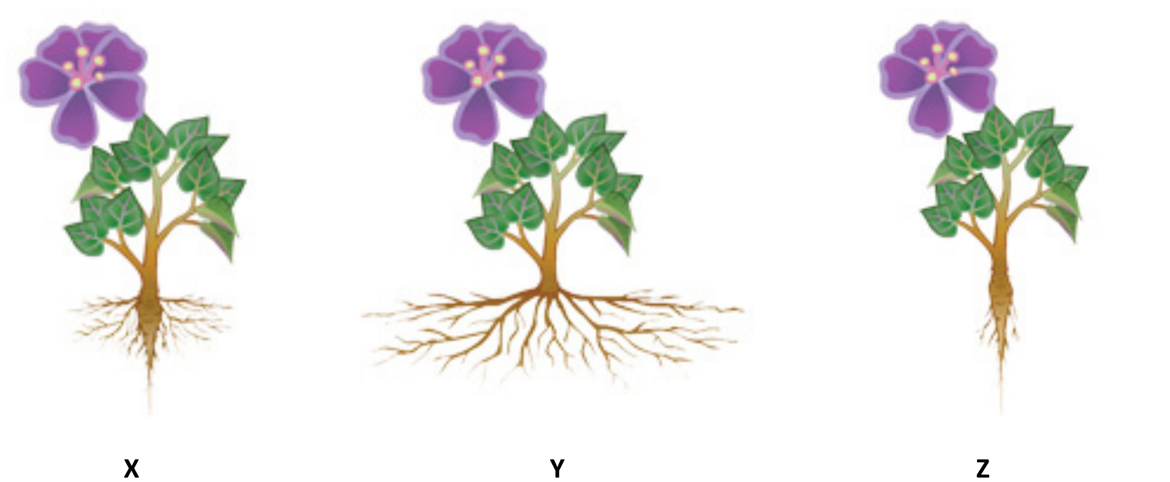


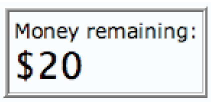
Figure 2. The three types of plants and their roots.

The three plants and their roots are shown on page 4. Plant Z has deep taproots to help it reach water below dry soil. Plant Y has shallow roots reminiscent of swamp plants. Plant X is in between. Plant X grows best in the flower box with a medium amount of water. Plant Y grows best in the wettest soil and Plant Z grows best in the driest soil.

The Virtual Field Model

In this activity, students also use a model of a "Virtual Field" (page 5). The field model is very similar to the Virtual Field model students used in Activity 3. However, the color gradations in the field now represent the amount of water in the soil. <u>The goal of the model is to have students plant a minimal number of one type of Mystery Plant and watch as the field populates with different varieties.</u> If a student has understood the idea that offspring vary and can then live under different conditions, which they learned with the Mystery Plant leaf adaptation, they should be able to transfer their knowledge to this task.

In the model below, students are asked to fill the field with plants by planting as few seeds as possible. They are given 20 seeds at a cost of $1 per seed and are asked to “spend” as little as possible.



A skillful student will choose to plant just one seed in the driest portion of the field and watch as the entire field populates with plants. He or she should be able to articulate the reason why this happened, namely that the original population of plants had enough offspring with different roots that, over time, the population adapted to live in soil with higher amounts of water. A less skillful student might plant seeds across the model, even though most of them will not survive.

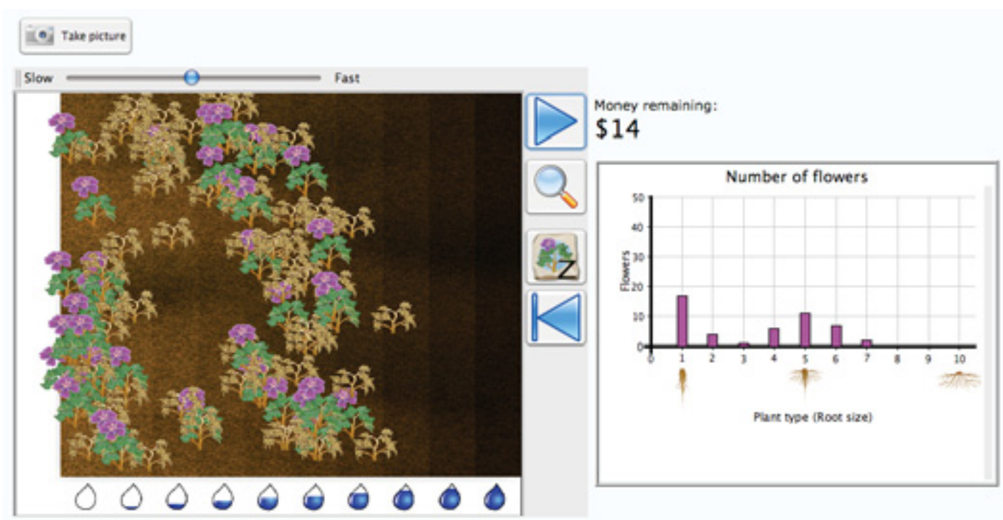


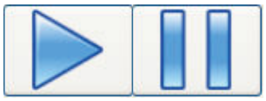
Figure 3. The plant population is evolving. Plants can now survive in wetter parts of the field.

The graph to the right of the model shows the number of healthy plants. The graph is key to understanding how the population is changing. When students start the model there will only be one bar on the graph, but as the model runs there will be more and more types of plants. <u>Due to randomness in variation, each student’s graph will be different. Spend time as a class interpreting the graph.</u>

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.



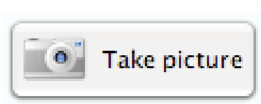
Click the Play button to start the model. Use the Pause button to stop it.

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

Click a seed packet icon and then click inside a flower box to plant a seed of that type. Plant X grows best in the middle flower box. Plant Y grows best in the wettest flower box. Plant Z grows best in the driest flower box.

The Carry button allows students to pick up a plant and move it to a different location. Students should notice that the root size and shape for each plant is different when they move plants from one box to another. Note: if students try to move a plant outside a flower box, it will "snap back" to its original location.

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.

Begin by discussing adaptations in plants. The activities in this unit have focused on plant leaves. What other features of plants help them survive in different environments? Can students name multiple adaptations in the same plant or animal that helps it survive in its environment? For example:

- A cactus is adapted to desert life. To keep animals at bay, cacti have sharp spines to deter animals from eating them. Note: In a cactus, what we commonly call the leaf of the plant is actually the stem, which is succulent and capable of photosynthesis. The spines are the true "leaves" of the cactus plant.
- A cheetah has spotted fur that helps it hide in tall grass, making it easier to stalk other animals without being seen. In addition, cheetahs can run extremely fast (65-70 mph) to catch their favorite foods, impalas and gazelles.
- A great white shark is a darker grey on top and white on the bottom so that it is camouflaged both to fish looking up at it from below and to fish looking down on it from above. In addition, great whites have large, strong jaws with multiple rows of teeth to catch and eat prey.

? 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.

> *How does a population of one type of plants evolve into a new type of plant?*

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.

Page 3

Q1. What differences do you notice between Mystery Plants X, Y and Z?
A. Student responses will vary. The size and shape of the roots are different although the leaves and flower colors are the same.

Students are asked to determine where each plant grows best. It may be difficult for some students to keep track of where they planted each seed type, since the plants all look the same "from above" – that is, their leaves and flower colors are the same. If students have trouble remembering where Mystery Plant Y grew best, have them return to the model on the previous page and ask them to plant only Plant Y seeds. After they find out where Plant Y grows best, have them reset the model and try another seed type.

Q2. Where did Mystery Plant Y grow best? Hint: go back to the previous page and try planting just Mystery Plant Y. (**Be sure to look at the roots!**) And then come back here to answer this question.
A. Flower Box 5.

Q3. Where did Mystery Plant Z grow best?
A. Flower Box 1.

Page 4

Q4. Which plant grows well in soil that is very wet?
A. Y

Q5. Do you think Mystery Plant babies can have variations in their roots?
A. Yes

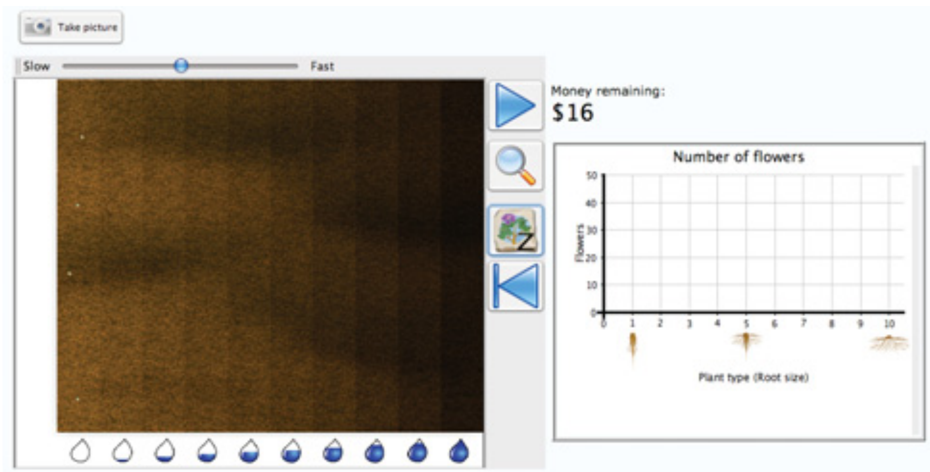
Q6. What do you think would happen if you planted Mystery Plant Z in a field that had different water levels?
A. Plant Z's offspring will adapt to living in other parts of the field.

Note: Questions 5 and 6 are multiple-choice questions, though they do not provide immediate feedback to students as other questions do. Students will get to test their ideas with the model on the next page.

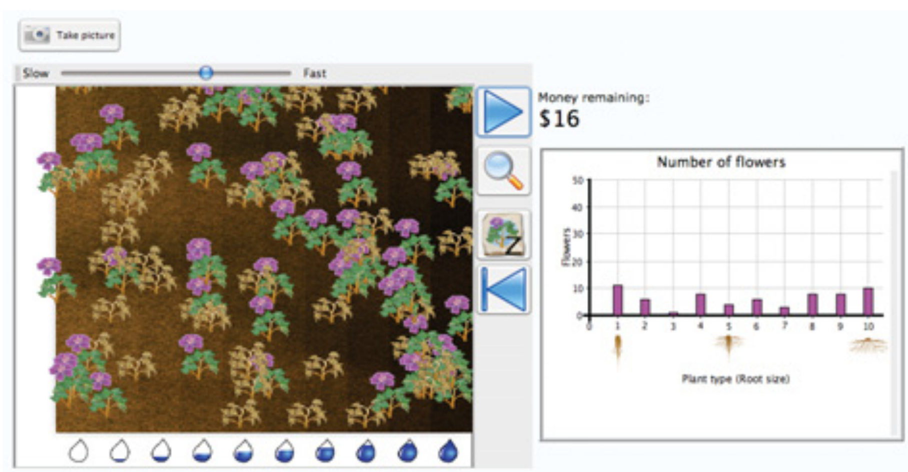
Stop students here and discuss their predictions. What do students think will happen in the Virtual Field?

Page 5

Students are asked to run the model and take pictures for their Lab Book. The two pictures should be similar to the following:



The field with fours seeds planted in the driest part (far left). Note: some students may plant only one seed in this area, while others may plant seeds throughout the field.



The field filled with plants after many generations. Note that graphs may vary, but should have bars throughout – from Root Size 1 to 10.

Page 6

Q7. Do all the plants in the field have the same type of roots?
A. No.

Q8. Lots of different plants grew in the Virtual Field, even though you planted only one type. How did that happen?
A. Student answers will vary. Students should describe how they planted one variety of plant and, over time, variation in the plants' seeds allowed the plants to grow in different environments. Over many generations, the plant population had adapted to live in all the different parts of the field.

Wrap up the activity with the discussion below.

4. Discuss the activity (Explain)

As students interact with the models, make sure to observe their work. Do they understand how the field in the second model became populated with plants? Refer the students back to the timeline and discuss the amount of time it takes for evolution to happen in real life—millions of years!

It is also important to discuss the discovery question with your students:

How does a population of one type of plants evolve into a new type of plant?

Ask the students how this model is the same as the field model in Activity 3 where they planted the Leaf Type 5 plant in the middle of the field and after many generations, the entire field was filled with different types of mystery plants adapted to live under different amounts of sunlight.

Students should make a connection to the Activity 3 model. When a plant's seeds scattered, some of the offspring in Activity 3 were able to live under different amounts of sunlight because they had different sized leaves. In this activity, plant offspring with variation in root size were able to live with a different level of water if their seeds landed in a different environment. In each successive generation, seeds carrying variations in root type landed in slightly different environments and had the chance to grow. After many, many generations, the entire field was filled with plants with roots that were adapted to thrive in the ten different water levels.