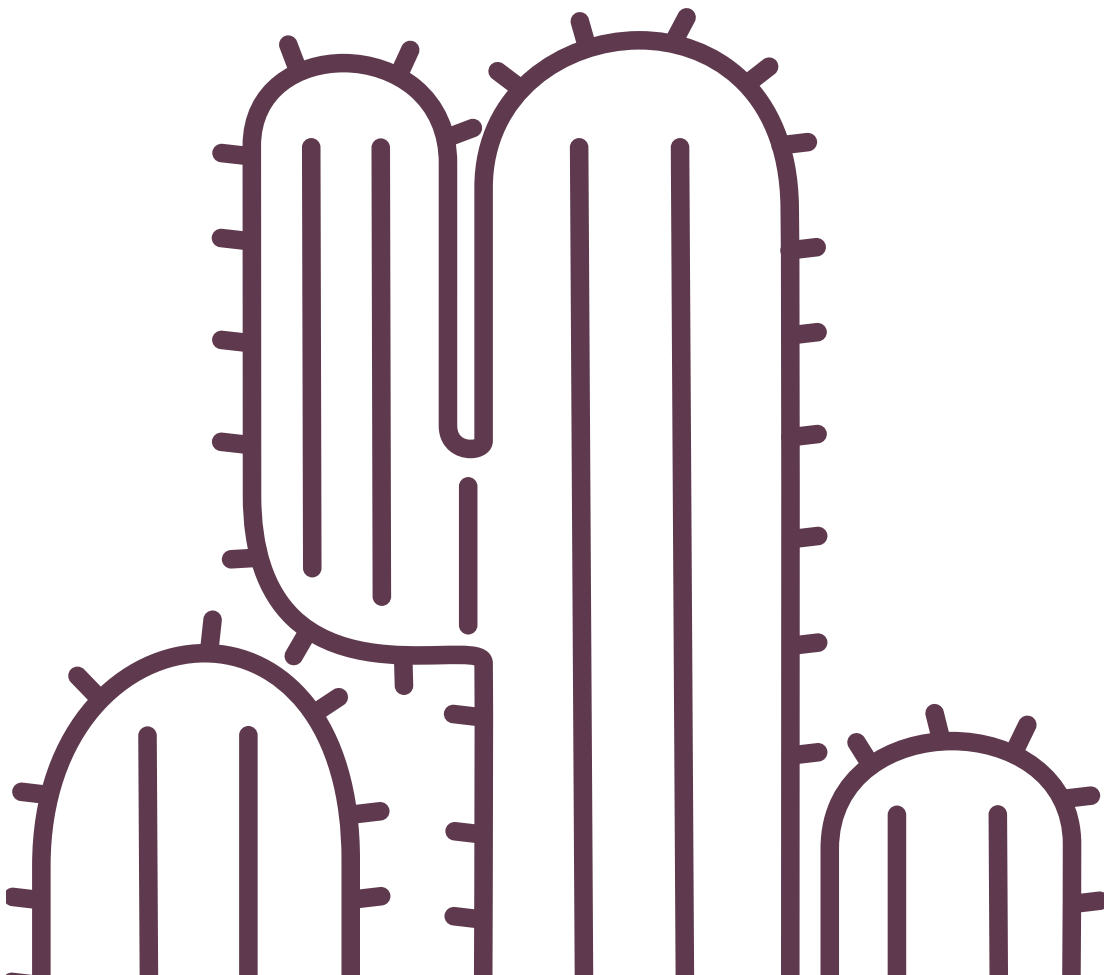


GARFIELD PARK  
CONSERVATORY  
ALLIANCE 

# ADAPTATIONS

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LESSON PLAN



## Change: Life's Only Constant

**Focus:** Adaptations and evolution—all organisms evolve to have different adaptations in order to survive...plants included! Intended for middle and high school students.

**Lesson Duration:** 70 Minutes

**Objective:** SWBAT articulate how plants have changed over time to develop the traits they have today.

**NGSS Standards:** HS-LS4-2, HS-LS4-4

**Vocabulary:** Mutation, variation, adaptation, natural selection, evolution

**Materials:** Plastic spoons, tweezers, binder clips, test-tube holders, paper/plastic cups, lima beans, paper clips or envelopes, copies of Bird Beak Lab, matching activity, Eve's Needle photo, and Plants in our Changing Climate

**Advance Prep:** Set up Bird Beak Lab by organizing piles of beans and "beaks." Make sure the vocabulary/terms for the matching activity are cut out and separated into envelopes or piles clipped together with paper clips. Make copies of resources.

### TEACHER BACKGROUND INFO

Populations of all living things are always changing and becoming better adapted to their environments to better enable survival. Variation, or differences in traits among individuals, exists in all populations and arises from mutation and sexual reproduction. Mutation is simply an error in the DNA of an organism, which alters its traits. Mutations can be beneficial, harmful, or neutral. Sexual reproduction also causes variation: combining the DNA of one parent with the DNA of another parent creates unique genetic combinations in the offspring, which will be identical to neither the mother nor the father.

Invariably, more offspring are born than can survive due to limited resources. Because of the variation in a population, some individuals will be better equipped to survive than others. Adaptations are traits individuals have that increase that individual's chances of survival and reproduction. Those that are better adapted to their environments will be able to survive, reproduce, and pass on genes for those adaptations to their offspring; this is called natural selection. Over time, this produces changes in a population as a whole. Evolution is this change over time. Natural selection is the mechanism by which evolution occurs. It is important to understand that individuals do not evolve; populations do. For example, an arctic rabbit that is born darker does not change in the course of its lifetime to have white fur. Rather, the dark rabbit will be less likely survive to reproductive age, so the genes for dark fur will be less likely to get passed on to subsequent generations. We see the evolution occurring slowly, over generations of time.

Populations of plants evolve, just like populations of animals. Cacti spines, for example, evolved from leaves. Thousands of years ago, cacti had leaves. Due to mutation, some cacti had leaves that were smaller than leaves of other cacti. This turned out to be an adaptation because the smaller surface area of the leaf meant reduced water loss for the cacti. Therefore, the cacti with smaller leaves survived to reproduce and pass on the genes for smaller leaves to their offspring. Over time, cacti leaves grew smaller until they became what we know today as spines. One plant that we have in our Desert House is called Eve's Needle. It is a very primitive cactus that has both leaves and spines. The leaves are also shaped rather like spines. This plant provides a great window into the middle of the evolution process, as we see a species that has some spines, but has not fully evolved out of growing leaves.

Cacti spines are just one example of many incredible plant adaptations. Plants adapt to their needs: sunlight, water, nutrients, reproduction, protection against predators, etc. Many plants have adapted wide, flat leaves to catch the sunlight. Others adapt aerial roots to provide stability for the plant. Read through the Adaptations Experience on our website to learn more about different types of plant adaptations!

## Change: Life's Only Constant

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### ENGAGE (5 MIN)

Show students the photo of the Eve's Needle cactus (a plant we have in the Conservatory!). Have students brainstorm questions about the plant. Tell them the plant is from the desert. Have them brainstorm more questions now that they know this fact. Based on its structures, what do you think its functions are? Why do you think it has both needles and spines? If we told you that many thousands of years ago, this plant had wide, flat leaves, what would you think about that? How and why do you think this plant changed over time to look like it does in the photo?

### EXPLORE (15 MIN)

Students will complete the Bird Beak Lab. Please see the lab for all instructions. Given the results of the lab, what do you think will happen to our fictional bird population over time?

- The birds with the beaks that were able to pick up the most food will be able to survive to reproduce. Over time, we will see more birds with those beaks. Birds with beaks that hardly picked up any food will not survive so their traits will not be passed on. Connect this back to the Eve's Needle photo!
- It is important to stress throughout this experiment that all of the birds are members of the same species even though their beaks are different. If students have trouble grasping this, explain that people are all part of the human species, but we don't all look exactly the same—our noses are shaped differently, our eyes are not all the same color, etc.

### EXPLAIN (20 MIN)

Each team will receive a copy of the matching activity. Students will try to match the vocabulary with the definition and step of cactus spine evolution. Time students for five minutes. Do not give them any assistance or guidance—see what they can come up with on their own. As you go through the vocabulary in next part of the lesson, have them correct mistakes they have made by moving the slips of paper around so that everything is matched correctly.

#### Points to cover:

- Variation exists within all populations. This can be due to genetic mutation and/or sexual reproduction.
- Some individuals will be better adapted to surviving than others. Those individuals will survive to reproduce and pass on their genes. Individuals who are less adapted will die or not be able to reproduce.
- Over time, the population of individuals will contain more of the traits that help individuals to survive. Traits that are not useful will disappear. This process is called natural selection.
- Explore the parallels between the evolution of spines in cacti and what happened in the bird beak lab.
- Evolution is change over time; it happens over generations. Natural selection is the mechanism of evolution.
- Individuals do not evolve; populations do.
- Evolution is constantly happening. Bring up Eve's Needle again and challenge students to frame the Eve's Needle phenomenon using their new vocabulary.

## Change: Life's Only Constant

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### EXPLAIN (CONT.)

#### Questions to pose:

- What is some variation that exists among plants? What is some variation within our classroom population?
- How do you think variation happens in the first place, in both plant and animal populations?
- What sorts of adaptations do plants have that help them survive?
- How are the adaptations of tropical plants different from those of desert plants?
- How is the evolution of spines in cacti related to the bird beak lab?
- Why does evolution happen?
- What do you think will happen over time to the leaves of Eve's Needle? What do you think the leaves of Eve's Needle used to look like, generations ago?

### EXTEND (25 MIN)

Evolution is always happening because the pressures individuals face are always changing. Many of the challenges plants face today have to do with climate change. Have students read about field mustard plants and thyme. Write and discuss how our changing climate has affected the evolution of these species.

### EVALUATE (5 MIN)

Students will answer the following question on an exit slip: Thousands of years ago, cacti had leaves instead of spines. How did these leaves become spines? Explain using the following terms: mutation, variation, adaptation, natural selection, evolution.

### RESOURCES

Bird Beak Lab

Matching Activity

Eve's Needle photo

Plants in our Changing Climate

Sources for Plants in our Changing Climate:

<http://www.smithsonianmag.com/science-nature/ten-species-are-evolving-due-changing-climate-180953133/>  
[http://evolution.berkeley.edu/evolibrary/news/060701\\_warming](http://evolution.berkeley.edu/evolibrary/news/060701_warming)

Supplement this lesson plan with a visit to the Garfield Park Conservatory, where you can learn about the adaptations of plants we have in our collection, including Eve's Needle, with the help of our amazing resources! Register your group at <https://garfieldconservatory.org/group-visits/school-field-trips/>.

If you are unable to bring your students to the Conservatory for a visit, you can still learn about the adaptations of our plants by accessing resources like our Adaptations Experience Guidebook here: <https://garfieldconservatory.org/resource-center/learning-experiences/>.

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

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

## Bird Beak Lab



### Lab Activity:

Today you and your lab group will be finches trying to eat as much food as possible. While you are all the same species of finch, your "beaks" are all a bit different: spoon, tweezers, binder clip, and test tube holder. You will use your beaks to collect as much of the food source (Lima beans!) as possible.

### Materials:

- 1 small plastic cup (stomach) for each member of your group
- 1 set of, spoon, tweezers, binder clip, and test tube holder (beak)
- Lima beans (food source on the island)

### Scientific Question:

Which beak type will allow the finch to pick up the most amount of food in your island?

### Hypothesis:

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### Procedure:

1. Lima beans should be in a pile on your table.
2. Each student will receive 1 utensil (beak), which you will have throughout the whole lab.
3. You will have exactly 20 seconds to collect as much of the food as they can using only the beak.  
**YOUR SURVIVAL DEPENDS ON YOUR ABILITY TO GATHER FOOD!**
4. Each time you pick up the food, you must put it in the stomach (cup) and then you can go back for more.
5. After the first trial, record your data on the data table below.
6. Repeat steps 3-5 for trials 2 and 3.
7. Only use your beak to pick up Lima beans — NOT to interfere with the other "finches."
8. Do not use your hands to help you! Only use your particular beak!

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

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

### Lima Bean Island Results

Beak Type	Trial 1: # of lima beans picked up	Trial 2: # of lima beans picked up	Trial 3: # of lima beans picked up
Spoon			
Tongs			
Binder Clips			
Test Tube Holder			

1. On a sheet of graph paper, graph your data.

2. Based on your data and observations, which beak was most fit to survive and how do you know?  
Was your hypothesis correct?

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3. If you returned to Lima Bean Island in 50 years, what would you expect to see in terms of beak type and why?

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4. How can this experiment help us understand how Eve's Needle came to have spines and spine-shaped leaves?

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

### Matching Activity:

Cut out 5-6 sets of the vocabulary terms, definitions, and examples (number of sets will depend on how many groups of students you will have in a class). See if students can match the terms with their corresponding definitions and examples!



TERM	DEFINITION	EXAMPLE
Mutation	A change in DNA	Not all individuals in a population of desert plants have the same DNA. These differences in DNA could be due to mistakes in different individuals or because of sexual reproduction—when the DNA of two parent plants combine to create offspring, a new, unique set of DNA is in the offspring.
Variation	Differences	Some desert plants have bigger leaves, while others have thinner leaves.
Adaptation	Traits that help individuals better survive.	Thinner leaves lose less water due to evaporation. This is helpful for the desert plants, which live in a hot, sunny, dry climate.
Natural Selection	The process where individuals that are better adapted to their environment will be able to survive, reproduce, and pass on their genes to their offspring.	Plants with thinner leaves survive to reproduce and pass on their genes for thinner leaves. Plants with bigger leaves lose too much water and do not survive.
Evolution	Change over time	Over generations, the plant population grows to have only thinner leaves. The thinner the leaves are, the less water the plants lose, so as generations pass, leaves continue to get thinner and thinner until eventually, instead of leaves, these plants have spines. These plants are what we know today as cacti.

## Eve's Needle:





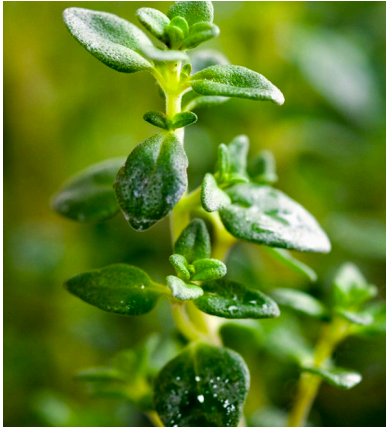
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## Plants in our Changing Climate

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Living things are always evolving because their environments are always changing! Today, plants all over the world are evolving because of climate change. Read about a couple of these changes below and answer some questions about how changing climate is resulting in evolving plant species.



### Thyme:

Varieties of Mediterranean thyme produce oils with different chemical compositions, and the ones with stronger smelling compounds like phenols are more effective at deterring herbivores. Producing phenols typically comes at a cost, though, as these plants are more sensitive to freezing. But in southern France, winters are getting warmer. Since the 1970s, the basin has seen fewer freezing nights during the cold season.

Looking at 24 populations across the southern France in 1974 versus 2010, one study found an increase in the number of plants that produce phenolic compounds. These plants are even popping up in areas where they didn't grow in the 1970s. It's likely that wild thyme is producing more phenols in response to warmer winters.

1. How do phenols benefit thyme?

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2. What is the downside of phenols?

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3. What is happening to the Mediterranean thyme? Discuss in terms of adaptations and natural selection.

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4. What are you wondering after reading about the Mediterranean thyme?

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

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



### Field Mustard:

Field mustard plants have evolved in response to an extreme, four-year-long drought in southern California, which some sources have linked to global warming. These plants flower and produce seeds near the end of the rainy season, but when the rainy season is cut short by a drought, plants that bloom later in the rainy season may wither and die before they can produce seeds. This form of natural selection favors early bloomers. Researchers compared plants grown from wild seeds collected before and after the drought and found that post-drought plants had evolved to flower much earlier — sometimes by as much as 10 days!

1. When do field mustard plants flower and produce seeds?

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2. What happens to field mustard plants if a drought causes the rainy season to end early?

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3. Why did post-drought plants flower earlier? Discuss in terms of natural selection.

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4. How is the case of the field mustard similar to what happened to the Eve's Needle cactus? How is it different?

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

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

## Exit Ticket

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1. Thousands of years ago, cacti had leaves instead of spines. How did these leaves become spines? Explain using the following terms: mutation, variation, adaptation, natural selection, evolution.

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2. Think of a plant that you've seen at school, in your neighborhood, or somewhere you've travelled. What is an adaptation that it has? How does that adaptation help it survive?

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