



## Natural Selection

**Length of Lesson:** 50-60 minutes

**Content Standards Addressed in Lesson:**

TEKS6.12E describe biotic and abiotic parts of an ecosystem in which organisms interact;

TEKS7.11B explain variation within a population or species by comparing external features, behaviors or physiology of organisms that enhance their survival

TEKS7.11C identify some changes in genetic traits that have occurred over several generations through natural selection and selective breeding such as the Galapagos Medium Ground Finch or domestic animals (Reporting Category 4 – Supporting Standard)

**NSES (1996) Grades 5-8 – Content Standard C**

- An organism's behavior evolves through adaptation to its environment. How a species moves, obtains food, reproduces, and responds to danger are based in the species' evolutionary history.
- The number of organisms an ecosystem can support depends on the resources available and abiotic factors, such as quantity of light and water, range of temperatures, and soil composition. Given adequate biotic and abiotic resources and no disease or predators, populations (including humans) increase at rapid rates. Lack of resources and other factors, such as predation and climate, limit the growth of populations in specific niches in the ecosystem.
- Biological evolution accounts for the diversity of species developed through gradual processes over many generations. Species acquire many of their unique characteristics through biological adaptation, which involves the selection of naturally occurring variations in populations. Biological adaptations include changes in structures, behaviors, or physiology that enhance survival and reproductive success in a particular environment.

**Scientific Investigation and Reasoning Skills Addressed in Lesson:**

TEKS6&7.2E analyze data to formulate reasonable explanations, communicate valid conclusions supported by the data, and predict trends.

TEKS6&7.3B use models to represent aspects of the natural world

6&7.3C identify advantages and limitations of models such as size, scale, properties, and materials

**NSES (1996) Grades 5-8 – Content Standard A**

- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.

### **I. Student Prerequisite Skills/Understandings**

- A basic understanding of traits, adaptations and mutations.

### **II. Objectives: Students will be able to**

1. Understand how adaptations help organisms survive by interpreting line graphs of the population of a species over time.
2. Develop conceptual understanding of natural selection by exploring how limiting factors, abiotic and biotic parts of an ecosystem and mutations interact and contribute to the survival of a species.
3. Define positive, negative and neutral mutations and give examples.
4. Assess the usefulness of models in scientific investigations.
5. Propose modifications to a model by considering how it mimics a real world event.

### **III. Supplies Needed**

- One computer per pair of students

### **IV. Advanced Preparation**

- If time permits, load Natural Selection PhET (see: <http://phet.colorado.edu/en/simulation/natural-selection>) onto computers by downloading the simulation in advance and saving it to a USB flash drive.

# 5E Organization

## Engage (5 minutes)

**Content Focus:** Animals have adapted to survive in their environments.

Show three images of animals blending into their environments. Ask students to point out the animal in the picture and explain how the animal's appearance helps the animal survive in its habitat.

| Questions to guide students' learning and thinking  | Questions to gather information about students' understanding and learning  |
|---|---|
| <ul style="list-style-type: none"><li>• [Picture 1] What do you notice about this picture?</li><li>• [Picture 2] I see the bird in this picture. Is there another animal in the picture?</li><li>• [Picture 3] What do you see?</li></ul> | <ul style="list-style-type: none"><li>• Why do you think these animals look this way?</li><li>• What other animals use camouflage? How does it help them survive?</li></ul> |

Introduce the Question of the Day, "How do certain factors influence an organism's ability to survive in its habitat?"

- ✓ **Checkpoint:** Students can identify the animals in the pictures and explain how their appearance contributes to their survival.

## Explore – *Natural Selection* PhET (30-35 minutes)

**Content Focus:** explain variation within a population or species by comparing external features, behaviors or physiology of organisms that enhance their survival using the *Natural Selection* PhET simulation

**Investigation Skills:** communicate valid conclusions supported by observations, use models to represent aspects of the natural world

Pass out one laptop per pair of students. Assign each student the role of Driver or Navigator. Allow students 5 minutes to explore the simulation. Collect students' attention and have a few students share what they have discovered. Pass out activity sheets and allow students 30 minutes to complete investigations.

| Questions to guide students' learning and thinking   | Questions to gather information about students' understanding and learning   |
|--|--|
| <ul style="list-style-type: none"><li>• What are a few differences between the two environments?</li><li>• What can you change about the bunnies?</li><li>• What happens when you select a limiting factor?</li><li>• What does the graph show? How could you use it to solve your challenges?</li></ul> | <ul style="list-style-type: none"><li>• Why do you think the wolves eat the white bunnies in the equator environment?</li><li>• What does the simulation not consider?</li><li>• How would you change the simulation to make it seem like a true ecosystem? Why?</li><li>• How do mutations alter a species?</li><li>• How do animals adapt in different seasons?</li><li>• Why do you think more bunnies die each generation with food than without food, if no</li></ul> |

- mutation factor is selected?
- What strategies did you use to answer the challenges?
- If you were a scientist, when would a computer simulation be useful?
- Why do you think scientists study adaptations/natural selection/mutations?

✓ **Checkpoint:** Students have completed their investigations.

### Explain (15 minutes)

**Content Focus:** describe biotic and abiotic parts of the *Natural Selection* PhET simulation, explain variation within a virtual population of bunnies by comparing external features or physiology of the bunnies that enhance their survival, identify some changes in genetic traits that have occurred over several generations through natural selection using the *Natural Selection* PhET simulation

**Investigation and Reasoning Skills:** analyze observations (data) to formulate reasonable explanations, communicate valid conclusions supported by the data, and predict trends, use the *Natural Selection* PhET to represent aspects of the natural world, identify advantages and limitations of the *Natural Selection* PhET such as size, scale, properties, and materials

Before discussing the challenges, pass out vocabulary sheets and introduce the vocabulary words: trait, adaptation and mutation. Relate each to the simulation. Discuss the students' results to each challenge introducing limiting factor and positive, negative and neutral mutations. Allow students to fill in the "examples from simulation" column on their worksheets with their partners. Review biotic and abiotic factors. Allow students to share examples from the simulation. Explain that the simulation is titled "Natural Selection" and allow students to develop their own definition for natural selection based on their experiences. Select a few students to share their definition with the class. Share the scientific definition and note similarities/differences from students' definitions. Discuss the usefulness of using computer models and advantages/disadvantages of using a simulation.

| Questions to guide students' learning and thinking   | Questions to gather information about students' understanding and learning   |
|--|--|
| <ul style="list-style-type: none"> <li>• What could you change about the bunnies?</li> <li>• What happened to the next generation of bunnies when you selected brown fur?</li> <li>• What is an example of something you inherited from your parents?</li> <li>• What happened to the bunnies after we added a friend?</li> <li>• What else have we seen today that relates to the experience with the simulation?</li> <li>• Biology is often called the study of living things. What do you think biotic factors are?</li> </ul> | <ul style="list-style-type: none"> <li>• If the bunnies in the next generation had the mutation you selected, what does that tell you about traits?</li> <li>• In the simulation you were able to select mutations, what does this mean you were able to change about the bunnies?</li> <li>• For Challenge 1, what did you select for the environment? Why was this environment a good choice?</li> <li>• For Challenge 1, what did you select as the selection factor? Why?</li> </ul> |

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|--|---|
| <ul style="list-style-type: none"> <li>Abiotic factors are the opposite of biotic factors. What do you think abiotic factors are?</li> </ul> | <ul style="list-style-type: none"> <li>For Challenge 2, what was the mutation you selected? How did this mutation help the bunny survive?</li> <li>What environment did you select for Challenge 2? Did it matter which one you selected? Why or why not?</li> <li>For Challenge 3, how were the bunnies able to take over? Why?</li> <li>Give an example of when brown fur was a positive mutation.</li> <li>Give an example of when brown fur was a negative mutation.</li> <li>What biotic factors were present in our simulation? Abiotic factors? How did these contribute to the survival of the bunnies?</li> <li>When would it be useful for a scientist to use a computer simulation?</li> <li>Based on the limitations of the simulation, how would you change the simulation to make it better?</li> </ul> |
|--|---|

✓ **Checkpoint:** Students are able to communicate their conclusions and observations using the simulation as evidence making connections to new vocabulary words.

### Elaborate (5-10 minutes)

**Content Focus:** identify some changes in genetic traits that have occurred over several generations through natural selection such as the Galapagos Medium Ground Finch

Explain that Charles Darwin was a scientist in the 1800s who went on a five year voyage to survey and map coastlines around the world. Throughout his journey, Darwin kept detailed notes of his observations. One area of interest to him was the Galapagos islands where he observed finches. Show the students pictures of the finches and ask students to consider the types of variation they observe. Ask the students to develop a series of steps that could have happened to cause the finches to all have different beaks. After a few minutes, collect students' attention and have a few groups share. Introduce the term "adaptive radiation" as explaining the diversification of a group of organisms into forms filling different ecological niches. If necessary, break down the definition into simpler terms describing diversification and niches.

| Questions to guide students' learning and thinking  | Questions to gather information about students' understanding and learning   |
|---|--|
| <ul style="list-style-type: none"> <li>Describe the types of variation you see in the illustrations of Darwin's finches.</li> </ul> | <ul style="list-style-type: none"> <li>Why do you think each species' variation makes it well adapted to its habitat?</li> <li>What features make the species' variation well adapted for its food supply?</li> <li>What are some other examples of adaptive radiation?</li> </ul> |

- ✓ **Checkpoint:** Students have shared their ideas and teacher has introduced the definition for adaptive radiation.

## Evaluate

Use evaluations in attached documents.



**Pictures for Engage**

**Picture 1:**



<http://science.howstuffworks.com/environmental/life/zoology/all-about-animals/animal-camouflage1.htm>

**Picture 2:**



<http://www.newscientist.com/article/dn13944-chameleons-finetune-camouflage-to-predators-vision.html>

Picture 3:



<http://www.stevegettle.com/pages/2008/10/08/>



Question of the Day:

**How do certain factors influence an organism's ability to survive in its habitat?**


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

### Natural Selection PhET Simulation


- 1) Play with the simulation for five minutes. Be prepared to share what you have found!
- 2) Fill in the table below with your observations.

| How can you...              | What did you change? | How many generations did it take? |
|-----------------------------|----------------------|-----------------------------------|
| ...make more white bunnies? |                      |                                   |
| ...make 20 brown bunnies?   |                      |                                   |


- 3) **Challenge 1:** Find a way to make the bunnies take over with brown fur! Fill in the table with your selections.

| Mutation  | Environment | Selection Factor | Observations |
|---|-------------|------------------|--------------|
|  |             |                  |              |

- 4) **Challenge 2:** Find a way to make 200 bunnies when food is a selection factor! Fill in the table with your selections.

| Mutation | Environment | Selection Factor  | Observations |
|----------|-------------|---|--------------|
|          |             |  |              |

5) **Challenge 3:** Find a way for the bunnies to take over when the environment is the artic! Fill in the table with your selections.

| Mutation | Environment   | Selection Factor | Observations |
|----------|---|------------------|--------------|
|          |  |                  |              |

6) On your own: Simulations are useful for understanding how natural processes work but are not always representative of the real world. How does this simulation differ from what might happen in a true ecosystem?

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7) On your own: What changes would you make the simulation to make it a better representation of a true ecosystem?

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

### Vocabulary Words

| Word              | Definition | Examples from simulation |
|-------------------|------------|--------------------------|
| Trait             |            |                          |
| Adaptation        |            |                          |
| Mutation          |            |                          |
| Limiting Factor   |            |                          |
| Biotic            |            |                          |
| Abiotic           |            |                          |
| Natural Selection |            |                          |




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

Natural Selection PhET Simulation  
KEY

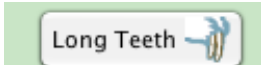



- 1) Play with the simulation for five minutes. Be prepared to share what you have found!
- 2) Fill in the table below with your observations.

| How can you...                      | What did you change?   | How many generations did it take? |
|-------------------------------------|--|-----------------------------------|
| ...make more white bunnies?         | Click "Add a friend"   | 1                                 |
| ...make more than 15 brown bunnies? | Click "Add a friend" and wait until second generation, click "Brown Fur" and wait two more generations | 3                                 |

- 3) **Challenge 1:** Find a way to make the bunnies take over with brown fur! Fill in the table with your selections.


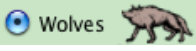
| Mutation  | Environment  | Selection Factor  | Observations   |
|---|--|---|--|
|  | <input checked="" type="radio"/> Equator  | <input checked="" type="radio"/> Wolves  | The wolves eat all of the white bunnies, but the brown bunnies survive. You have to wait awhile but you can speed it up by pressing the "forwards" button. If the bunnies had a long tail it didn't make a difference. |

- 4) **Challenge 2:** Find a way to make 200 bunnies when food is a selection factor! Fill in the table with your selections.

| Mutation  | Environment   | Selection Factor  | Observations   |
|---|---|---|--|
|  | <input checked="" type="radio"/> Arctic <br><input checked="" type="radio"/> Equator  | <input checked="" type="radio"/> Food  | The environment did not matter. It takes a few generations to make 200 bunnies. Eventually all the bunnies have long teeth. If the bunnies had a long tail it didn't make a difference. <b>Teacher Note: the bunnies cannot take over the world in this situation.</b> |



5) **Challenge 3:** Find a way for the bunnies to take over when the environment is the artic! Fill in the table with your selections.

| Mutation | Environment   | Selection Factor  | Observations   |
|----------|---|---|--|
| None.    |  |  | The white bunnies blend in with the snow, and the wolves do not eat them. The bunnies could have a long tail and it wouldn't matter. |

6) On your own: Simulations are useful for understanding how natural processes work but are not always representative of the real world. How does this simulation differ from what might happen in a true ecosystem?

In a true ecosystem, there may be other predators and different types of food. The bunnies would also have to interact with other organisms.

7) On your own: What changes would you make the simulation to make it a better representation of a true ecosystem?

The simulation could include some more controls, such as, adding additional organisms or changing the weather more than artic or equator.

Vocabulary Words  
Key

| Word              | Definition   | Examples from simulation                       |
|-------------------|--|--|
| Trait             | A characteristic   | Fur color, long teeth, long tail               |
| Adaptation        | A trait that helps an organism survive                                     | Bunny with brown fur in an equator environment |
| Mutation          | A change to an organism's DNA  | Fur color, long teeth, long tail               |
| Limiting Factor   | Things that prevent a population from growing any larger                   | Food, wolves (predators)                       |
| Biotic            | A living component of an ecosystem   | Bunnies, food, wolves                          |
| Abiotic           | A nonliving component of an ecosystem                                      | Sunlight, weather                              |
| Natural Selection | The process by which organisms better adapted to their environment survive | The whole simulation!                          |



Galapagos Island Finches



**small ground finch**  
*Geospiza fuliginosa*



**medium ground finch**  
*Geospiza fortis*



**large ground finch**  
*Geospiza magnirostris*



**cactus finch**  
*Geospiza scandens*



**large cactus finch**  
(Genovesa)  
*Geospiza conirostris*



**large cactus finch**  
(Española)  
*Geospiza conirostris*



**sharp-beaked ground finch**  
*Geospiza difficillis*



**small tree finch**  
*Camarhynchus parvulus*



**large tree finch**  
*Camarhynchus psittacula*



**woodpecker finch**  
*Cactospiza pallidus*



**vegetarian finch**  
*Platyspiza crassirostris*



**warbler finch**  
*Certhidea olivacea*

