Lesson Plan: Natural Selection and Climate Change

Teacher- contributed lesson plan by Dr Jaspreet Kaur, Maitreyi College and Dr Simran Jit, Miranda House, (University of Delhi), India.

As a **high school** or **undergraduate**, **Biological Sciences** teacher, you can use this set of computer-based tools to teach about **natural selection,** its **role in evolution** and **climate change as a selective pressure** in natural selection.

This lesson plan will enable the students to understand Darwin's theory of natural selection. They will learn how organisms such as pocket mice and Snowshoe hares respond to changes in the environment and climate. The lesson plan will allow students to understand climate change as a selective pressure in natural selection and how it plays a role in the evolutionary rescue of a species that would otherwise be endangered due to climate change.

Thus, the use of this lesson plan allows you to integrate the teaching of a climate science topic with a core topic in the Biological Sciences.

Use this lesson plan to help your students find answers to:

- What is Darwin's theory of natural selection? Illustrate this with an example.
- What is genetic polymorphism?
- Why is genetic variation critical to the survival of a species?
- What is selective pressure? How does it affect allelic frequencies in successive generations of a population of organisms?
- How does natural selection play a role in the evolutionary rescue of a species, that would otherwise be endangered due to climate change?

About the Lesson Plan

Grade Level: High School, Undergraduate

Discipline: Biological Sciences

Topic(s) in Discipline: Natural Selection, Selective Pressure, Evolution, Speciation, Evolutionary Hotspots, Genetic Polymorphism, Genetic Variants, Allelic Frequencies, Adaptive Advantage

Climate Topic: Climate and the Biosphere

Location: Global

Access: Online

Language(s): English

Approximate Time Required: 30-60 min

1 Contents

An in-chapter reading that briefly introduces Darwin's theory of natural selection.

https://www.nap.edu/read/5787/chapter/3 (Chapter 3, pgs 11-16)

2. Interactive video (~10 mins)

An interactive video to illustrate Darwin's theory of natural selection. It uses the example of fur coat colour in pocket mice.

http://media.hhmi.org/biointeractive/interactivevideo/pocketmousequiz/?_ga=2.29903743.1389041280.1548303730-1054415675.1543821439

3. Video and associated reading (10 mins)

A video and associated reading that shows that climate change can be a selective pressure in natural selection. It uses the example of coat colour in the Snowshoe hare populations in North America.

https://www.youtube.com/watch?v=NwZzmTuhs3M

http://www.umt.edu/research/millslab/stories/Science%20Paper.php

4. Classroom/ Laboratory activity (Optional)- (15-30 min)

An optional computer lab-based simulation activity to illustrate the changes in single gene allelic frequencies under a varying selective pressure.

http://www.mhhe.com/biosci/genbio/virtual_labs/BL_12/BL_12.html

5. Suggested questions/assignments for learning evaluation

- What is Darwin's theory of natural selection? Illustrate this with an example.
- What is genetic polymorphism?
- Why is genetic variation critical to the survival of a species?

- What is selective pressure? How does it affect allelic frequencies in successive generations of a population of organisms?
- How does natural selection play a role in the evolutionary rescue of a species, that would otherwise be endangered due to climate change?

2 Step-by-step User Guide

Here is a step-by-step guide to using this lesson plan in the classroom/laboratory. We have suggested these steps as a possible plan of action. You may customize the lesson plan according to your preferences and requirements.

1. Topic introduction and discussion

Use the in-chapter reading, "Major Themes in Evolution", from the National Academies Press (Chapter 3, pgs 11-16) to introduce the topic of natural selection. Use this resource to explain how Darwin and Wallace proposed the theory of natural selection on variants within a species that explained the process of evolution. Also explain how Mendel's work explained how favored characteristics are inherited and eventually lead to speciation.

This can be accessed at https://www.nap.edu/read/5787/chapter/3

2. Illustrate the theory with an example

Use this interactive resource titled "The Making of the Fittest: Natural Selection and Adaptation" by Howard Hughes Medical Institute to illustrate an example of natural selection. Explain how a selection pressure of dark coloured surfaces on light coloured pocket mice has resulted in a natural selection for darker coloured pocket mice that are better camouflaged against predators. Use the questions from this resource to quiz students on their understanding of the theory of natural selection when a selective pressure is in play.

This can be accessed at http://media.hhmi.org/biointeractive/interactivevideo/pocketmousequiz/index.html

3. Corelate this understanding to a climate related example of natural selection in another species

Play the video, "Will Snowshoe Hares Win the Race between Evolution and Climate Change", by National Geographic to explain how reduced snowfall due to a warming climate, behaves as a selective pressure on the seasonal coat colour polymorphism of the Snowshoe hares in North America. Snowshoe hares change coat colour in different seasons- white when the ground is snow covered and brown when it is not-to protect themselves from predators. Use the resource to stress that that snowshoe hares from areas where the ground is snow-covered or from areas where the ground is rarely covered with snow through the year, show no seasonal change in coat colour. Emphasize that the areas in between these regions are where most hares that seasonally change their coat colour can be found. Use the associated reading, "Mills Lab publishes new article in Science: Research identifies areas where evolution could rescue animals threatened by climate change" by the Mills Lab, University of Montana, to show that research on the Snowshoe hares has established that these intermediary zones are evolutionary hotspots that show a higher percentage of non- colour changing brown snowshoe hares due to the ground remaining snow free for longer as a result of a warming climate. Explain how this is an example of 'evolutionary rescue' of a species by selection for a character that affords better protection from predators in a changing environment, in this case, due to climate change.

The video can be accessed at https://www.youtube.com/watch?v=NwZzmTuhs3M

The associated reading can be accessed at http://www.umt.edu/research/millslab/stories/Science%20Paper.php

4. Extend this thinking by using this simulation (Optional)

This activity can be conducted, if the teacher wishes to extend the students' understanding of natural selection by their observations of changes in allelic frequencies over successive generations, due to an adaptive advantage for varying selective pressures. Use the simulation, "Natural Selection" by McGraw-Hill Education, to explain to students how the allelic frequencies for a single gene, that codes for body colour, changes through several generations when a varying selection pressure (different environments) is applied.

- Launch the simulation and follow the instructions to run it.
- Select an initial allelic frequency for alleles 'A' and 'a' of a gene for body colour in a starter population of insects, for a given environment.
- Click the 'Natural Selection' tab and then the 'Generation' button, in order from G1 to G5.
- Record the data generated in table for changes in allelic frequencies over five generations.
- Use the 'Reset' button and repeat this activity for different allelic frequencies of the starter population for a varying environment.
- End-point allelic frequencies can also be compared by varying the allelic frequencies at the start for a given environment.
- The students can then plot graphs depicting the changes in allele frequencies through the generations.
- Students can also use the worksheet to record their observations and fill in answers to the journal questions to provide explanations for their observations.

This exercise will enable students to observe the changes in allelic frequencies over successive generations. They will be able to understand that if an allele is associated with an adaptive advantage, its frequency will increase in a population and may eventually get fixed while an allele that does not have an advantageous adaptive trait, will decrease in frequency and may eventually be lost from the population. Finally, extend their thinking by discussing with the students how a climate related change in environment could play a role in changing the allelic frequencies for the given gene.

This activity can be accessed at http://www.mhhe.com/biosci/genbio/virtual_labs/BL_12/BL_12.html

5. Questions/Assignments

Use the tools and the concepts learned so far to discuss and determine answers to the following questions:

- What is Darwin's theory of natural selection? Illustrate this with an example.
- What is genetic polymorphism?
- Why is genetic variation critical to the survival of a species?
- What is selective pressure? How does it affect allelic frequencies in successive generations of a population of organisms?
- How does natural selection play a role in the evolutionary rescue of a species, that would otherwise be endangered due to climate change?

3 Learning Outcomes

The tools in this lesson plan will enable students to:

- explain Darwin's theory of natural selection
- explain changes in gene frequencies over successive generations due to a selective advantage
- understand how natural selection affects biodiversity
- describe the role of different selective pressures on the evolution of a species

4 Additional Resources

If you or your students would like to explore the topic further, these additional resources will be useful.

1. Series of videos

Introduce the topic of “Natural and Artificial Selection” through a series of videos by Howard Hughes Medical Institute.

http://media.hhmi.org/biointeractive/click/Selection/01.html

2. Model/ Simulation (High School)

Use the model/ simulation, “How can natural selection be modeled?” by Glencoe/McGraw-Hill Education to show how mutations get selected for or against, under varying selective pressures for a given population of organisms.

http://www.glencoe.com/sites/common_assets/science/virtual_labs/LS06/LS06.html

5 Credits/Copyrights

1. **Reading; "Major Themes in Evolution"** (Chapter 3, pgs 11-16)

Textbook reading from "TEACHING ABOUT EVOLUTION AND THE NATURE OF SCIENCE", by the National Academies Press

2. **Interactive Video Quiz; "Making of the Fittest: Natural Selection and Adaptation"**

Video presented by the Howard Hughes Medical Institute (HHMI Biointeractive)

3. **a. Video; "Will Snowshoe Hares Win the Race between Evolution and Climate Change"**

   Video presented by the National Geographic YouTube Channel

   b. Associated reading; "Mills Lab publishes new article in Science: Research identifies areas where evolution could rescue animals threatened by climate change"

   A summary of the research that supports the above video is provided by the Mills Lab, University of Montana

4. **Simulation; "Natural Selection"**

Presented by McGraw Hill Education

5. **Additional Resources**

Howard Hughes Medical Institute (HHMI Biointeractive)

Glencoe/McGraw-Hill Education