Lesson Plan: Evolutionary Adaptations to Climate Change

Teacher-contributed lesson plan by Dr Rajendra Phartyal and Dr Mansi Verma, Sri Venkateswara College (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 **evolutionary adaptations** in animals due to climate change.

Evolutionary Adaptation is the **morphological** or **physiological** adjustment of organisms to their environment to improve their chances of survival. With climate change associated altered precipitation patterns, rising sea-levels, and extreme weather events, ecosystems across the globe are being disrupted. This lesson plan includes resources that explain how climate change is affecting many animals species and how they are adapting to their changed environments.

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

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

- What is evolutionary adaptation? Give suitable examples.
- How is adaptation different from phenotypic plasticity, in response to environmental changes?
- How is climate change influencing evolutionary adaptations in living organisms?

About the Lesson Plan

Grade Level: High School, Undergraduate

Discipline: Biological Sciences

Topic(s) in Discipline: Evolutionary Adaptations, Natural Selection, Phenotypic Variations, Genetic Variations, Gene Frequency, Phenotypic Plasticity, Morphological or Physiological Traits, Epigenetic Factors

Climate Topic: Climate and the Biosphere

Location: Global

Access: Online, Offline

Language(s): English

Approximate Time Required: 30-100 min

1 Contents

1. Reading (10 min)

A reading to introduce the topic of adaptation in living organisms.

This can be accessed at:

https://www.britannica.com/science/adaptation-biology-and-physiology

2. Video (~5 min)

A video that briefly explains how and why animals are adapting in response to climate change.

This can be accessed at:

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

3. Reading (15 min)

A reading to explain how climate change induced evolutionary adaptations occur in several animal species.

This can be accessed at:

https://blogs.ei.columbia.edu/2018/03/30/helps-animals-adapt-not-climate-change/

4. Optional: Teaching Module (2 sessions of 35 min each)

A detailed case study of the willow leaf beetle's adaptation in North America to a warming climate.

This can be accessed at:

https://evolution.berkeley.edu/evolibrary/article/0_0_0/dahlhoff_rank_01

5. Suggested questions/assignments for learning evaluation

- What is evolutionary adaptation? Give suitable examples.
- How is adaptation different from phenotypic plasticity, in response to environmental changes?
- How is climate change influencing evolutionary adaptations in living organisms?

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 text, 'Adaptation' by Encyclopedia Britannica, to introduce the topic of adaptation in living organisms. Explain the need of several species to adapt to changing environments in order to improve their chances of survival. Describe the main characteristics of evolutionary adaptations. Discuss how natural selection works on variations in the species' populations leading to- inherited morphological or physiological changes- adaptations. Emphasize on how it differs from other favorable circumstances like useful traits and phenotypic plasticity in organisms, in order to adjust to environmental aberrations. Finally, discuss the different examples given in text like the adaptation of the peppered moth in wing coloration from the beginning of the industrial revolution, to drive in the point of evolutionary adaptations.

This can be accessed at:

https://www.britannica.com/science/adaptation-biology-and-physiology

2. Introduce climate change as a driver of evolutionary adaptation in the wild

Use the video, 'Can wildlife adapt to climate change?' by Erin Eastwood for TED-Ed, to briefly introduce your students to climate change as a driver of evolutionary adaptation in several animal species in the wild. Use the examples in the video to point out how climate change has led to disrupted ecosystems and changed environments for many animal species. Finally, emphasize on their need to adapt in order to improve their rates of survival.

This can be accessed at:

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

3. Improve understanding of climate change induced evolutionary adaptations

Use the blog, 'What Helps Animals Adapt (or Not) to Climate Change?' by Renee Cho, Earth Institute, Columbia University to discuss the different aspects of evolutionary adaptations to climate change in animals. Explain how a warming climate forces animals to 'move, adapt or die'. Use the text to discuss examples of organisms such as corals that show evidence of climate related adaptations. Describe the role of epigenetics in the phenotypic plasticity of several species that permits them to survive better in unfavorable conditions. Use the examples in the text to explain how this gives 'time' (to evolve) for several species to develop adaptations to changing environmental conditions. Also, discuss some examples where phenotypic plasticity is not an advantage. Finally, use the text to discuss how important it is to maintain large species populations and the biodiversity of Earth to allow for short time-scale evolutionary changes to adapt to a changing climate.

This can be accessed at:

https://blogs.ei.columbia.edu/2018/03/30/helps-animals-adapt-not-climate-change/

4. Optional: Use a case study of the willow leaf beetle to extend understanding of evolutionary adaptations to a warming climate

Use this teaching module, 'Natural selection from the gene up: The work of Elizabeth Dahlhoff and Nathan Rank' by the Understanding Evolution team, University of California Museum of Paleontology, to examine the research of these scientists to better understand how natural selection shapes the evolutionary process leading to adaptations in the willow leaf beetle, the subject of warming climatic conditions.

Note that this teaching module addresses 3 key questions (as given in the module):

- How do biologists study natural selection in the wild?
- How do differences at the genetic level translate into changes in populations and ecology?
- What are evolutionary trade-offs?

This module is designed such that one or more components may be used for your teaching. Navigate through the 12 pages of this module by using the tab in the upper right-hand corner of the webpage. Each page can be printed separately or viewed in print format. Download the student reading guide (link given at bottom of the webpage) and distribute copies to your students. Use this guide to channel your students through the different aspects of this study using an enquiry-based method (questions given in guide). Go to page 11 of the module for a list of discussion and extension questions. Use the list to encourage your students to elaborate on their understanding of evolutionary adaptations in a warming climate.

This can be accessed at:

https://evolution.berkeley.edu/evolibrary/article/0_0_0/dahlhoff_rank_01

5. Questions/Assignments

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

- What is evolutionary adaptation? Give suitable examples.
- How is adaptation different from phenotypic plasticity, in response to environmental changes?
- How is climate change influencing evolutionary adaptations in living organisms?

3 Learning Outcomes

The tools in this lesson plan will enable students to:

- learn about how different animal species cope with environmental changes
- understand what evolutionary adaptations are and how they differ from phenotypic plasticity or traits
- discuss how living organisms are evolving to adapt to climate change

4 Additional Resources

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

1. Reading; 'Ten Species That Are Evolving Due to the Changing Climate'

A Smithsonian Magazine report by Helen Thompson that talks about ten species that are evolving due to a changing climate.

This can be accessed at:

https://www.smithsonianmag.com/science-nature/ten-species-are-evolving-due-changing-climate-180953133/?page=1

2. Classroom/Laboratory Activity; 'Animal Adaptations for Survival'

A middle school level classroom activity by Vanderbilt University, USA, to explain the role of certain adaptations for survival in animals.

This can be accessed at:

https://www.vanderbilt.edu/cso/Animal_Adaptations_for_Survival_Lesson.pdf

5 Credits/Copyrights

All the teaching tools in our collated list are owned by the corresponding creators/authors/organizations as listed on their websites. Please view the individual copyright and
ownership details for each tool by following the individual links provided.
We have selected and analyzed the tools that align with the overall objective of our project and have provided the corresponding links. We do not claim ownership of or responsibility/liability for any of the listed tools.

1. **Reading; 'Adaptation'**

By Encyclopedia Britannica.

2. **Video; 'Can wildlife adapt to climate change?'**

By Erin Eastwood for TED-Ed.

3. **Reading; 'What Helps Animals Adapt (or Not) to Climate Change?'**

Blog by Renee Cho, Earth Institute, Columbia University.

4. **Teaching Module; 'Natural selection from the gene up: The work of Elizabeth Dahlhoff and Nathan Rank'**

By the Understanding Evolution team, University of California Museum of Paleontology.

5. **Additional Resources**

Helen Thompson, Smithsonian Magazine

Vanderbilt University