

Lesson Plan: Impact of Climate Change on Photosynthesis

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As a **high school or undergraduate Biological Sciences** teacher, you can use this set of computer-based tools to help you in teaching **photosynthesis, factors affecting photosynthesis**, and the impact of **increasing levels of atmospheric CO₂ and some climate-related factors on photosynthesis**.

This lesson plan enables students to understand the process of photosynthesis in plants and the various factors that influence it. Students will explore how changes in climate related factors such as CO₂ levels, temperature, water availability can influence photosynthesis, thereby impacting plant growth and agricultural yields. A hands-on lab activity will enable students to assess the change in the rate of photosynthesis when CO₂ concentration changes.

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 photosynthesis?
- What are the key differences between C3, C4, and CAM plants?
- How do plants respond to climate change?
- Discuss the impact of increasing global CO₂ levels on photosynthesis.
- Is global food security at risk due to climate change? Explain.

About the Lesson Plan

Grade Level:

High School, Undergraduate

Discipline:	Biological Sciences
Topic(s) in Discipline:	Photosynthesis in Plants, Factors affecting Photosynthesis, C3 Plants, C4 Plants, CAM Plants, Calvin Cycle
Climate Topic:	Climate and the Biosphere
Location:	Global
Access:	Online, Offline
Language(s):	English
Approximate Time Required:	100-120 min

1 Contents

1. Video micro-lecture (~12 min)

A micro-lecture that introduces the topic of photosynthesis.

<https://www.bozemanscience.com/photosynthesis>

2. Video micro-lecture (~7.45 min)

A micro-lecture to learn about how plants have evolved to respond differently to changing climatic conditions.

<https://www.youtube.com/watch?v=5ti09qMaLZU>

3. Reading (~20 min)

A reading to discuss the difference in the responses of C3 and C4 plants to rising levels of atmospheric CO₂.

<https://www.nature.com/scitable/knowledge/library/effects-of-rising-atmospheric-concentrations-of-carbon-13254108>

4. Classroom/Laboratory Activity (~60 min)

A classroom/laboratory activity to measure the rate at which photosynthesis occurs and note changes under variable conditions such as elevated carbon dioxide levels, a potential contributor to climate change.

<https://serc.carleton.edu/sp/mnstep/activities/26481.html>

5. Suggested questions/assignments for learning evaluation

- What is photosynthesis?
- What are the key differences between C3, C4, and CAM plants?
- How do plants respond to climate change?
- Discuss the impact of increasing global CO₂ levels on photosynthesis.
- Is global food security at risk due to climate change? Explain.

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. Introduce the topic by playing a video micro-lecture

Introduce the topic by playing the video micro-lecture, “[Photosynthesis](#)” from bozemanscience. This video explains the process of photosynthesis, chloroplasts and photoreceptors, the light reaction and the Calvin cycle, and an overview of C3, C4, and CAM plants.

The video micro-lecture can be accessed at

<https://www.bozemanscience.com/photosynthesis>.

2. Discuss the topic further by playing a video micro-lecture

Play the video micro-lecture, "[Plant Response to Climate Change](#)" by Prof. Raghu Murtugudde (content developed at Science Media Centre, IISER Pune), to explain that C3 and C4 type plants evolved differently as a response to changes in temperature and CO₂ levels. This micro-lecture explains the possible influence of CO₂ levels and climate change on the growth of plants and consequently on vegetation and crop productivity.

The video micro-lecture is accessible at

<https://www.youtube.com/watch?v=5ti09qMaLZU>.

3. Reading

Use the reading "[Effects of Rising Atmospheric Concentrations of Carbon Dioxide on Plants](#)" from Nature Education to discuss the effects of elevated CO₂ levels on the photosynthetic efficiency of field-grown plants. This reading states that plant physiology and biochemical compositions change in response to high CO₂ availability. Secondary effects like changes in stomatal conductance affect efficiency of carbon fixation and water uptake in plants. Thus, differences in the responses of C3 and C4 plants under these conditions are noted.

The reading is available at

<https://www.nature.com/scitable/knowledge/library/effects-of-rising-atmospheric-concentrations-of-carbon-13254108>

4. Classroom/Laboratory Activity

Explore, measure, and determine the rate at which photosynthesis occurs through a classroom/laboratory activity, "[Designing an experiment to test the rate of photosynthesis](#)" from the Minnesota Science Teachers Education Project. This lab activity will allow students to test the rate of photosynthesis under variable environmental conditions like light intensity, temperature, carbon dioxide levels.

In this lab activity, students can test the effect of elevated CO₂ levels on the rate of photosynthesis on spinach leaves by testing under different concentrations of added sodium bicarbonate. Students can then discuss how the rate at which photosynthesis occurs can affect food production in plants and thereby, affect agricultural produce in general.

The classroom/laboratory activity can be accessed at

<https://serc.carleton.edu/sp/mnstep/activities/26481.html>.

5. Questions/Assignments

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

- What is photosynthesis?
- What are the key differences between C3, C4, and CAM plants?
- How do plants respond to climate change?
- Discuss the impact of increasing global CO₂ levels on photosynthesis.
- Is global food security at risk due to climate change? Explain.

3 Learning Outcomes

The tools in this lesson plan will enable students to:

- Define photosynthesis.
- List the various factors that influence photosynthesis.
- Discuss the possible effects of elevated levels of CO₂ on field-grown plants.

4 Additional Resources

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

1. Simulator (~10 min)

A simple simulator that allows users to change a range of variables such as the color of light, brightness of light, and carbon dioxide concentration, and to then calculate their impact on the photosynthetic efficiency of a plant.

<https://scratch.mit.edu/projects/embed/133475453/?autostart=false>

Note: Adobe Flash Player is required to run this simulation activity.

2. Reading (~45 min)

A reading on the effects of global elevated CO₂ levels on photosynthesis and productivity of plants.

<http://www.indiaenvironmentportal.org.in/files/The%20impact%20of%20global%20elevated%20CO2.pdf>

3. Reading (~45 min)

A reading on the possible impact of climate change on food security.

<https://www.annualreviews.org/doi/full/10.1146/annurev-publhealth-031816-044356>

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. Video micro-lecture, “Photosynthesis”

Narrated and developed by Paul Andersen.

<http://www.bozemanscience.com/>

2. Video micro-lecture, “Plant Response to Climate Change”

Narrated by [Prof Raghu Murtugudde](#), content developed for the TROP ICSU project, developed at the [Science Media Centre, IISER Pune](#).

3. Classroom Activity, “Designing an experiment to test the rate of photosynthesis”

Developed by John S Olson for the Minnesota Science Teachers Education Project (MnSTEP), led by the Center for Global Environmental Education, available at [SERC Carleton](#).

4. Simulation, “Photosynthesis- A Simple Virtual Lab”

Designed and developed by the Lifelong Kindergarten Group at MIT Media Lab
<https://scratch.mit.edu/>

5. Reading, “The impact of global elevated CO₂ concentration on photosynthesis and plant productivity”.

Reddy, A. R., Rasineni, G. K., & Raghavendra, A. S. (2010). The impact of global elevated CO₂ concentration on photosynthesis and plant productivity. *Current Science*, 46-57.

[The impact of global elevated CO₂ concentration on photosynthesis and plant productivity](#)

6. Reading, “Potential Impacts on Food Security and Undernutrition”.

Climate Change and Global Food Systems: Potential Impacts on Food Security and Undernutrition. Samuel S. Myers et al. *Annual Review of Public Health*, Vol 38: 259-277.

<https://www.annualreviews.org/doi/full/10.1146/annurev-publhealth-031816-044356>