Lesson Plan: Carbon Cycle Regulation by Carbon Sequestration

Lesson plan developed with contribution from Gargi Khandelwal, St. Xavier's College, Mumbai, India.

As a **High School** or introductory **Undergraduate Environmental Sciences** or **Chemistry** or **Earth Sciences** teacher, you can use this lesson plan to teach your students about **Earth's carbon cycle**, its **role in Earth's climate**, its irregularities due to anthropogenic activities, and its regulation by **carbon sequestration**.

In this lesson plan, students will learn about the various components and processes involved in Earth's carbon cycle and its influence on Earth's climate. This lesson plan will enable students to learn through interactive exercises how disturbances in the carbon cycle due to human activities have contributed towards global warming and climate change. Through this lesson plan your students will also learn about processes of carbon sequestration to regulate the disturbed carbon cycle and its role in climate mitigation and adaptation.

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

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

1. What is the carbon cycle? Describe its components and processes.
2. How does the carbon cycle influence Earth's climate?
3. Why has the carbon cycle changed in recent times?
4. What is carbon sequestration and how does it regulate the carbon cycle?
5. Explain the importance of carbon sequestration in climate mitigation.

About the Lesson Plan

Grade Level: High School, Undergraduate

Discipline: Environmental Sciences, Chemistry, Earth Sciences

Topic(s) in Discipline: Carbon Cycle, Carbon Sequestration, Carbon Capture and Storage, Carbon Sources and Sinks

Climate Topic: Climate and the Atmosphere, Climate and the Biosphere, Climate and the Hydrosphere, Climate and the Anthroposphere, Climate Mitigation and Adaptation

Location: Global

Access: Online, Offline

Language(s): English

Approximate Time Required: 60 – 90 min

1 Contents

1. **Teaching Module (15-45 min)**

A teaching module to describe the components and explain the processes involved in the natural carbon cycle and its role in Earth's climate.

This can be accessed at:

https://scied.ucar.edu/carbon-cycle

2. **Infographic (5 min)**

An infographic to describe how the Earth's carbon cycle is changing due to anthropogenic activities.

The infographic can be accessed at:

https://climate.nasa.gov/climate_resources/136/infographic-earths-carbon-cycle-is-off-balance/

3. **Quiz (~10 min)**

An interactive online quiz to test student understanding of the carbon cycle and its influence on Earth's climate.

This can be accessed at:

https://climate.nasa.gov/climate_resources/96/quiz-carbon-and-the-climate/

4. Reading (30 min)

A reading to describe natural carbon sources and sinks and the role of carbon sequestration by carbon capture and storage for climate mitigation.

This can be accessed at:

https://www.britannica.com/technology/carbon-sequestration

5. Suggested questions/assignments for learning evaluation

- What is the carbon cycle? Describe its components and processes.
- How does the carbon cycle influence Earth's climate?
- Why has the carbon cycle changed in recent times?
- What is carbon sequestration and how does it regulate the carbon cycle?
- Explain the importance of carbon sequestration in climate mitigation.

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 carbon cycle and explain its role in Earth's climate

Use the teaching module, 'The Carbon Cycle' by University Corporation for Atmospheric Research (UCAR) to describe what the carbon cycle is and how carbon is cycled through different parts of the Earth- atmosphere, biosphere, lithosphere, and hydrosphere.

You may choose to use the 'related pages and diagrams' section to teach about the components and geochemical processes involved in the natural carbon cycle. Use the subsection 'The Changing Carbon Cycle' to explain how human activities are affecting the natural carbon cycle.

Finally, use the hands-on interactive activities in the 'related resources' section to elaborate on the role of the carbon cycle in Earth's climate.

This can be accessed at:

https://scied.ucar.edu/carbon-cycle

2. Extend understanding of the changing carbon cycle

Use the infographic, 'Earth's carbon cycle is off balance' by NASA to explain how higher concentrations of carbon dioxide in the atmosphere due to anthropogenic activities are affecting the natural carbon cycle.

The infographic can be accessed at:

https://climate.nasa.gov/climate_resources/136/infographic-earths-carbon-cycle-is-off-balance/

3. Enable discussion about how an off-balance carbon cycle contributes to climate change

Use the interactive online quiz, 'Carbon and the climate' by NASA to test student understanding of the various components of the carbon cycle.

Encourage a discussion on their influence on Earth's climate and how changes in them may contribute to climate change.

This can be accessed at:

https://climate.nasa.gov/climate_resources/96/quiz-carbon-and-the-climate/

4. Introduce carbon sequestration and describe its importance in climate mitigation

Use the reading, 'Carbon Sequestration' by Noelle Eckley Selin, Associate Professor of Engineering Systems and Atmospheric Chemistry, MIT, to describe natural carbon sources and sinks. Explain how their balance is affected by anthropogenic activities with higher concentrations of carbon dioxide being added to the atmosphere.

Use the text to emphasize on the importance of the removal of this excess carbon dioxide from the atmosphere using technologies for carbon capture and storage, and carbon sequestration. Use the various embedded links to elaborate on these geoengineering processes. Finally, initiate a discussion on the significance of carbon sequestration in regulating the carbon cycle and thereby, enabling climate mitigation.

This can be accessed at:

https://www.britannica.com/technology/carbon-sequestration

5. Questions/Assignments

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

- What is the carbon cycle? Describe its components and processes.
- How does the carbon cycle influence Earth's climate?
- Why has the carbon cycle changed in recent times?
- What is carbon sequestration and how does it regulate the carbon cycle?
- Explain the importance of carbon sequestration in climate mitigation.

3 Learning Outcomes

The tools in this lesson plan will enable students to:

- learn about the components and processes involved in Earth's natural carbon cycle
- discuss how human activities in recent times have affected the carbon cycle
- describe the natural sources and sinks of carbon on Earth
- discuss carbon sequestration through carbon capture and storage technologies
- explain the importance of carbon sequestration for climate mitigation

4 Additional Resources

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

1. Webpage

'Carbon Sequestration' on Science & Climate, UC Davis' website on climate change.

This can be accessed at:

https://climatechange.ucdavis.edu/science/carbon-sequestration/

2. Reading

An article, ‘Soil as Carbon Storehouse: New Weapon in Climate Fight’ by Judith D. Schwatz for YaleE360, published at the Yale School of the Environment.

This can be accessed at:

https://e360.yale.edu/features/soil_as_carbon_storehouse_new_weapon_in_climate_fight

3. Reading

An article, ‘Soil Carbon Storage’: Ontl, T. A. & Schulte, L. A. (2012) Soil Carbon Storage. *Nature Education Knowledge* 3(10):35

This can be accessed at:

https://www.nature.com/scitable/knowledge/library/soil-carbon-storage-84223790/

4. Video lecture

‘Rethinking carbon capture and sequestration’ by Roel Snieder, Department of Geophysics, Colorado School of Mines for MIT Energy Initiative.

This can be accessed at:

https://www.youtube.com/watch?v=q61e2r8g4dc

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. **Teaching Module; 'The Carbon Cycle'**

By University Corporation for Atmospheric Research (UCAR)

2. **Infographic; 'Earth's carbon cycle is off balance'**

By NASA: Climate Change and Global Warming

3. **Interactive online quiz; 'Carbon and the climate'**

By NASA: Climate Change and Global Warming

4. **Reading; 'Carbon Sequestration'**

By Noelle Eckley Selin, Associate Professor of Engineering Systems and Atmospheric Chemistry, MIT.

5. **Additional Resources**

UC Davis

Judith D. Schwatz for YaleE360, published at the Yale School of the Environment

Nature Education Knowledge

Roel Snieder, Department of Geophysics, Colorado School of Mines for MIT Energy Initiative