TOWNGREEN2025
Middle School Climate-Change Curriculum

Lesson 8

Carbon Cycles through Ecosystems

Unit Title: **Carbon Cycles through Ecosystems**	
Theme: **Ecosystems & Cycles**	Grade Level: **7**
# of sessions for the unit:	Session #8: **How does decomposition fit into the carbon cycle?**
Date created: **Summer 2017**	Author: **B. Allia, C. McWilliams**

CC Climate Change Curriculum

Unit Description

Focusing on systems and cycles, students use their understanding of climate-change and how carbon and thermal energy interact with Earth's land and atmosphere. Students practice skills such as argumentation and collecting and analyzing data. Students gain experience with the interactions of humans and Earth processes with ecosystem dynamics, and with developing solutions to complex climate-change issues. The lessons generally follow this order:

- Introduce unit and culminating event: climate-change's effect upon fauna
- analyze global temperature and carbon dioxide trends
- understand personal climate-change experiences, such as weather, matter and energy uses
- collect wetland and upland forest soil carbon-stores
- sample atmospheric carbon-store
- analyze land and atmospheric carbon-stores
- understand the carbon cycle, pre-human and human era
- describe personal experiences with solid forms of carbon changing into atmospheric carbon
- develop and present solutions to save a fauna from climate-change issues

Standard(s)

Based upon the 2016 MA Science & Technology/Engineering Curriculum Framework

MA LS2 Ecosystems: Interactions, Energy, and Dynamics

MA 7.MS-LS2-3 Develop a model to demonstrate how matter and energy are transferred among living and nonliving parts of an ecosystem and that both matter and energy are conserved through these processes

Unit Goals

1. Create an action plan to decrease carbon in the atmosphere, increase carbon stored by the land, and preserve natural carbon-stores in the ground
2. Build background knowledge of how carbon cycles within a local ecosystem
3. Understand relevant climate-change issues in order to make informed decisions
4. Identify authentic scientific processes, such as sampling, gathering, and analyzing land and atmospheric carbon-content data, in order to validate evidence regarding climate-change

Unit Objectives

Students will be able to

understand that:

1. Carbon cycles through the atmosphere and land
2. Human activities increases atmospheric carbon by burning fossil fuel
3. Atmospheric carbon is a "greenhouse gas"
4. Greenhouse gases increase global temperatures
5. Wetlands and uplands store different amounts of carbon above and below ground

and to:

1. Sample, collect, and analyze primary-source data
2. Collect and analyze secondary data as a means to validate causes of climate change

Lesson Objectives

Identify the process in which consumers emit carbon to the atmosphere, through decomposition

Note any potential barriers to the lesson — consider variability

Student challenges

- Through 7th grade, students begin a process of moving from a more concrete to an abstract perspective. For some students, this presents a developmental challenge since the carbon cycle is not directly observable or experienced.

Student Mitigating Factors

- Students draw concept drawings to make the invisible carbon cycle more concrete
- Students use tactile strategies to make the abstract carbon cycle more concrete

Teacher challenges

- Student access to websites

Evaluation/Assessment

(directly linked to the goals, i.e., Formative/Ongoing Assessment or Summative/End of Lesson Assessment)

Formative teacher check-in during small group jigsaw presentation, these understandings:

1. Soil microorganisms emit carbon dioxide into the environment.
2. Correlation that the increased soil exposure results in an increase of microorganisms and carbon dioxide emissions.
3. Soil microorganisms play a role in the carbon cycle.

Formative Homework Assignments:

1. Video — students take guided notes while watching "Soil Solutions to to carbon problems," a 4-minute video *https://www.youtube.com/watch?v=NxqBzrx9yIE*
2. Actively learn "Consumers & Decomposers" *www.activelylearn.com* (free subscription) Active reading assignment with aligned questions

Vocabulary

- respiration
- photosynthesis
- emissions
- sink
- carbon atom
- atmospheric carbon
- particle
- greenhouse gas
- methane gas

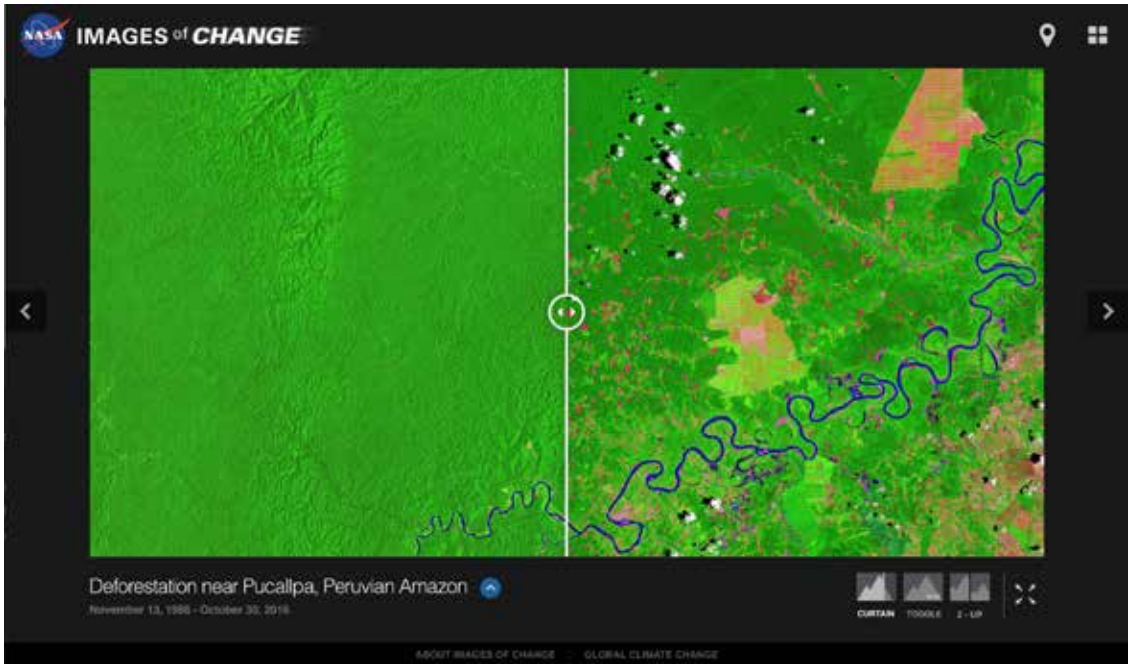
Differentiated Vocabulary Ideas

1. word wall
2. word splash
3. common prefixes and suffixes
4. content vocabulary roundtable
5. flashcards

NOTE: Consider the UDL Guidelines in selecting methods and materials to ensure that you provide options for engagement, representation, and action and expression.

Methods

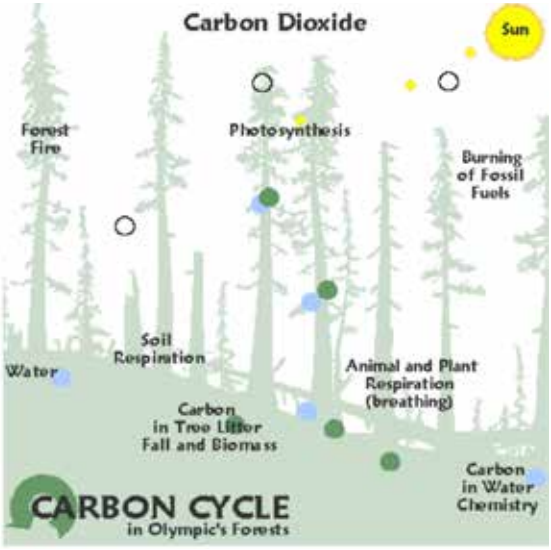
(e.g., Anticipatory Set, Introduce and Model New Knowledge, Provide Guided Practice, Provide Independent Practice)



Hook: Show students this picture and pose the question

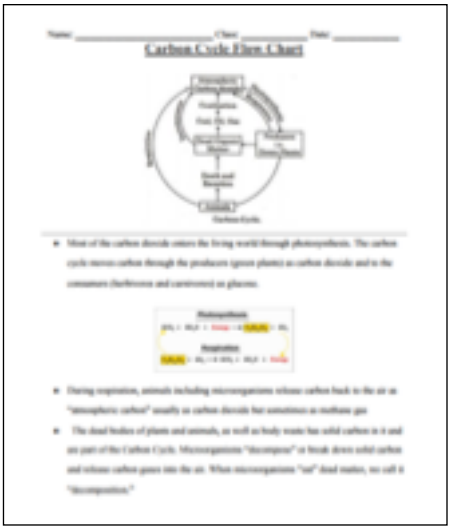
What happened in the Amazon between 1986 to 2016? (answer = deforestation)

1. Show students the animated carbon cycle in the below link
   http://www.res-bio.com/wp-content/uploads/2013/10/Carbon_Cycle-animated_forest.gif



   A. Students have studied photosynthesis and respiration, but these 2 decomposition carbon inputs are new:
      - soil respiration
      - carbon in tree litter fall and biomass

   B. Handout this Carbon Cycle Flow Chart (reproducible version included in materials)
      Teacher leads class discussion, reviewing familiar photosynthesis and respiration while introducing decomposition



   C. Students take notes on decomposition in their science notebooks/journals or on handout
      - Students tape handout into spiral bound notebooks or insert handout into binder

   D. Vocabulary Strategies
      1. Students apply one of the vocabulary strategies, as recommended in the above Vocabulary Section
      2. Students write vocabulary notes in their science notebook/ journal where they can easily refer to, during the unit

2. Decomposition Activity — "Get to know a soil microorganism"

   A. In small groups, students briefly research 1 of these 6 soil microorganisms
      - Actinomycetes bacteria
      - Mold Fungi Rhizopus
      - Slime molds
      - Spirogyra algae
      - Ciliate protozoa
      - Flagellate protozoa

B. Provide students with the list of websites to use, to save time during class. These websites have been reviewed for middle-school reading level. However, the teacher will need to assist students with some of the scientific terms in the websites.

C. Still in their small groups, students develop a short slide show on their soil microorganism (15 minutes)

D. Jigsaw student groups so that groups take turns presenting to each other. (15 minutes)

- Teacher asks students guiding questions to solicit responses:
  - **a.** that the soil microorganisms all emit carbon dioxide into the environment
  - **b.** that more soil exposure is correlated with an increase of microorganisms and carbon dioxide emissions
  - **c.** that he degree of decomposition of solid carbon is correlated with the amount of atmospheric carbon dioxide

E. Differentiate idea is to assign advanced students to research the topic of soil microorganism succession and to present it in the class' jigsaw rotation

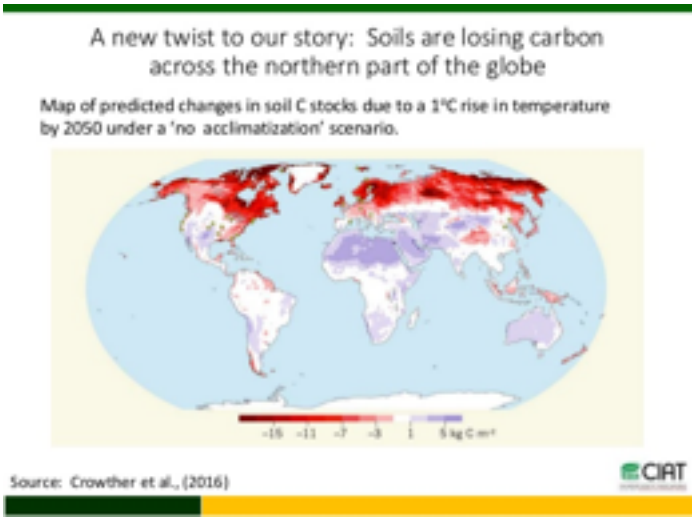
3. If the teacher has made or has access to a "compost in a bottle," such as this activity: *http://www.bottlebiology.org/investigations/decomp_main.html*

- After the compost is mature, with a carbon dioxide probe measure carbon dioxide content inside bottle and compare it with the ~350 ppm of CO_2 in the classroom
- This is evidence of microorganisms decomposing solid carbon into carbon dioxide
- This process occurs in soils naturally
- Soil decomposition and decomposition of matter increases carbon dioxide in the atmosphere
- When glaciers melt, more soil is exposed to decomposition, increasing atmospheric carbon (carbon dioxide)

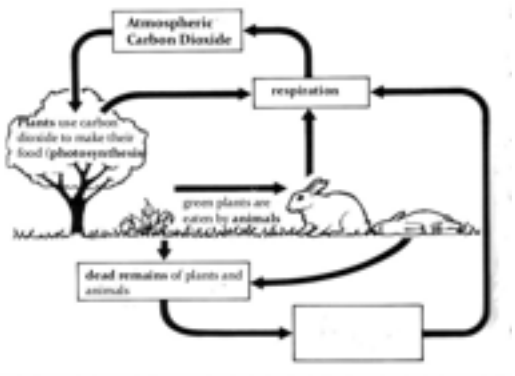
4. To conclude the class: Decomposers add carbon dioxide to the carbon cycle

A. Lead class discussion using these resources

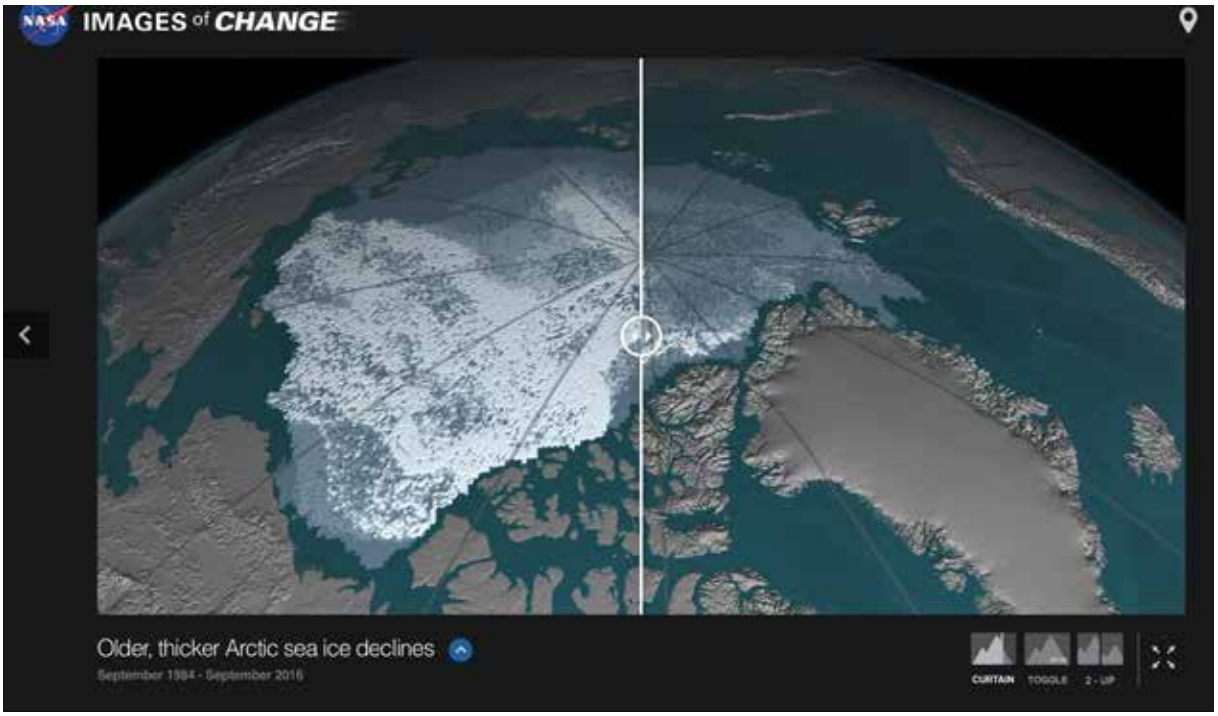
B. Increasing soil surface area increases atmospheric carbon dioxide



C. Decomposition contributes to respiration and carbon dioxide in the carbon cycle



D. Increasing global temperatures has significantly melted the Arctic Sea between 1984 and 2016: *https://climate.nasa.gov/images-of-change?id=591#591-older-thicker-arctic-sea-ice-declines*



E. Homework options

- Video — students take guided notes while watching "Soil Solutions to carbon problems" a 4-minute video *https://www.youtube.com/watch?v=NxqBzrx9yIE*
- Actively learn "Consumers & Decomposers" *www.activelylearn.com* (free subscription) Active reading assignment with aligned questions

Materials

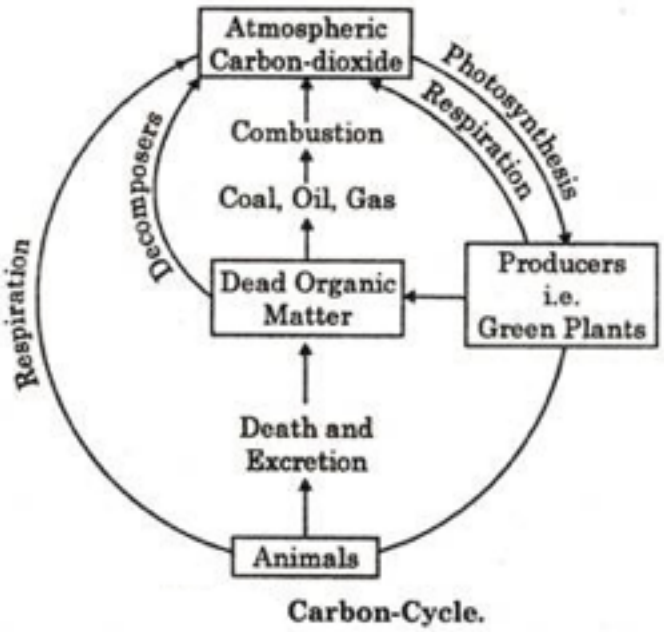
1. Student access to computers
2. Photocopy/distribute handouts provided in this lesson (below)
3. Bottle biology (optional) — started a few weeks before this lesson
4. Carbon dioxide probe for the optional Bottle Biology activity

Name: Block: Date:

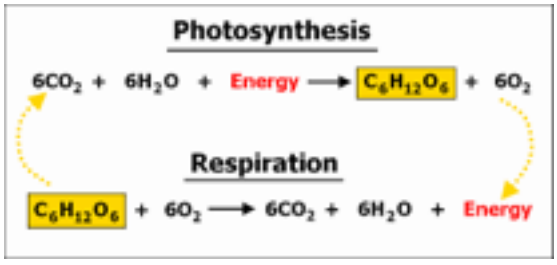
Lab Report

Carbon Cycles through Ecosystems

Carbon Cycle Flow Chart



- Most of the carbon dioxide enters the living world through photosynthesis. The carbon cycle moves carbon through the producers (green plants) as carbon dioxide and to the consumers (herbivores and carnivores) as glucose.



- During respiration, animals including microorganisms release carbon back to the air as “atmospheric carbon-dioxide, ” usually as carbon dioxide but sometimes as methane gas.
- The dead bodies of plants and animals, as well as body waste, contain solid carbon and they are part of the Carbon Cycle. Microorganisms “decompose” or break down solid carbon and release carbon gases into the air. When microorganisms “eat” dead matter, we call it “decomposition.”

6 types of Soil Microorganisms

Actinomycetes bacteria

1. *https://www.britannica.com/science/actinomycete*
2. Scroll down to Functions/Role of actinomycetes in this website: *http://www.agriinfo.in/default.aspx?page=topic&superid=5&topicid=148*
3. *https://extension.illinois.edu/soil/SoilBiology/bacteria.htm*

Mold Fungi Rhizopus

1. *https://www.britannica.com/science/Rhizopus*
2. *http://www.gopetsamerica.com/bio/fungi/rhizopus.aspx*
3. *https://extension.illinois.edu/soil/SoilBiology/fungi.htm*

Slime molds

1. *http://www.ucmp.berkeley.edu/protista/slimemolds.html*
2. *http://www.microbeworld.org/types-of-microbes/protista/slime-molds*
3. *https://www.scientificamerican.com/video/how-slime-molds-make-decisions/*

Spirogyra algae

1. *https://www.britannica.com/science/Spirogyra*
2. *http://bioweb.uwlax.edu/bio203/2010/fenske_megh/habitat.htm*
3. *http://www.qsstudy.com/biology/the-characteristics-and-habitat-of-plant-spirogyra.html*

Ciliate protozoa

1. *https://www.britannica.com/science/ciliate*
2. *https://extension.illinois.edu/soil/SoilBiology/protozoa.htm*
3. *http://www.microbeworld.org/types-of-microbes/protista/protozoa*

Flagellate protozoa

1. *https://wiki.kidzsearch.com/wiki/Protozoa*
2. *https://www.britannica.com/science/flagellate*
3. *https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/health/biology/?cid=nrcs142p2_053867*

Notes and Comments

Unit Resources for class discussion

BACKGROUND Decomposition is the process whereby organic material is broken down into its smaller molecules. The primary producers, plants, can then use these molecules again. Decomposition is one step in the food chain, and thus the nutrient cycle, of an ecosystem. Most plant matter, over 90% in terrestrial ecosystems, is not used by herbivores but is broken down by decomposers in the litter and soil. Decomposers, or detritivores, are organisms such as bacteria, fungi, flies and worms. They are consumers in the food chain, just as herbivores and carnivores are. Without detritivores, the Earth would quickly be covered with dead, but not decaying, organic matter. The nutrient cycle would grind to a halt because so many nutrients would be tied up in the dead matter and not available to living organisms.

Decomposition rates vary due to abiotic factors such as moisture level, temperature, and soil type. They also vary depending on the amount of initial breakdown caused by the prior consumers in the food chain. This means what form the organic matter is in, original plant or animal, partially eaten, or as fecal matter when the detritivore encounters it. The more broken down the matter, the faster the final decomposition.

Temperatures were especially hot in March in the Siberia, where permafrost melting is becoming increasingly worrying to climate scientists. A new study published in *Nature* the permafrost in the Arctic region is melting faster than anyone expected. There is twice as much carbon sequestered in the permafrost as there is in all the Earth's atmosphere today. When the permafrost melts, it releases that stored carbon, which warms the Earth even more, and leads to more permafrost melting. It's a dangerous feedback loop that could put the equivalent of all the carbon emissions locked in the Alberta tar sands into the atmosphere in a very short period of time.

The Arctic acts like a very large carbon freezer, which keeps the decomposition rate very low. That is changing, according to the report. Joe Romm, who is a leader of Think Progress, says, "We are leaving the freezer door wide open. The tundra is being transformed from a long-term carbon locker to a short-term carbon unlocker."