Garden Lesson G6-11

Carbon Cycle

**Communication**
Students learn about trees through poetry, visual aids, drawing, observation and discussion.

**Academics**
This lesson fulfills Next Generation Science Standards for Earth’s materials and systems; human impacts on Earth systems; global climate change; matter and energy flow in organisms; interdependent relationships in ecosystems; cycle of matter; energy in chemical processes; systems and system models; energy and matter; Common Core State Standards for integrating information presented in different media; collaborative discussion; speaking and listening; language; and acquiring words and phrases.

**Sustainability**
Trees play an important role in ecosystems and in reducing the impact of climate change. Students reflect on trees, the carbon cycle and how they relate to global warming.

**Nourishment**
Students are given the opportunity to breathe deeply and appreciate clean air, while they acknowledge the oldest organism in the garden and think beyond themselves and their own lifetimes.

**Life Skills**
Students make observations and ask questions, learn about the history of their school and town in relation to Grandmother Oak, practice gratitude and learn to write appreciations.
Carbon Cycle Abstract

Summary
In this 6th grade science lesson, students explore the oldest organism in the garden’s ecosystem: Grandmother Oak! They have an opportunity to observe the oak, draw a scientific model of her life cycle, discuss the role of the carbon cycle and photosynthesis in her life, and appreciate Grandmother Oak for what she gives to the garden.

Objectives
After this lesson, students will be able to:
• Identify what the Grandmother Oak tree gives to the garden (and what she takes)
• Discuss the life cycle of an oak tree
• Discuss the role of photosynthesis in the carbon cycle
• Discuss the role of trees in mitigating climate change
• Use observation and awareness to explore and investigate

Assessments
During this lesson, students will:
• Write an appreciation for something the Grandmother Oak gives to the garden
• Create and share a scientific model of Grandmother Oak’s life cycle
• Compare their models with the Grandmother Oak visual aid
• Trace the path of carbon through Grandmother Oak’s life
• Engage in the “I Notice, I Wonder, It Reminds Me Of...” thinking exercise

Communication is strengthened by learning through poetry, visual aids, drawing, observation and discussion. Sustainability is highlighted by investigating the role trees play in reducing the impact of climate change. Nourishment is given by the oldest organism in the garden as students breathe fresh air. Life Skills are practiced as students make observations, ask questions, practice gratitude and write appreciations.

Academically, Academics fulfill Next Generation Science Standards for Earth’s materials and systems; human impacts on Earth systems;
global climate change; matter and energy flow in organisms; interdependent relationships in ecosystems; cycle of matter; energy in chemical processes; systems and system models; energy and matter; Common Core State Standards for integrating information presented in different media; collaborative discussion; speaking and listening; and language. See Connections to Academic Standards below for details.

*Edible Schoolyard* curriculum emphasizes developing community and personal stewardship, along with skills that will help students navigate different situations throughout their lives; using observation and awareness; and acknowledging water as a precious resource.

This lesson follows the BEETLES Project’s *Learning Cycle* (Invitation-> Exploration -> Concept Invention -> Application -> Reflection) and uses their *Discussion Routines* (Think-Pair-Share, Whip-Around). All are highlighted in Green* with an asterisk for easy identification. See the documents BEETLES_Discussion_Routines.pdf and BEETLES_Learning_Cycle.pdf included in Resources below for more information. Games and activities from other sources are also identified in Green, without an asterisk.

**Connections to Academic Standards**

Next Generation Science Standards, Middle School Disciplinary Core Ideas:

- **ESS2.A: Earth’s Materials and Systems**
  - All Earth processes are the result of energy flowing and matter cycling within and among the planet’s systems. This energy is derived from the sun and Earth’s hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth’s materials and living organisms.
  - The planet’s systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth’s history and will determine its future.

- **ESS3.C: Human Impacts on Earth Systems**
  - Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth’s environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3)

  - Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS-ESS3-3),(MS-ESS3-4)

- **ESS3.D: Global Climate Change**
Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth’s mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities.

- **LS1.C: Organization for Matter and Energy Flow in Organisms**
  - Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (MS-LS1-6)
  - Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth, or to release energy. (MS-LS1-7)

- **LS2.A: Interdependent Relationships in Ecosystems**
  - Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)
  - In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1)
  - Growth of organisms and population increases are limited by access to resources. (MS-LS2-1)
  - Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. (MS-LS2-2)

- **LS2.B: Cycle of Matter and Energy Transfer in Ecosystems**
  - Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. (MS-LS2-3)

- **PS3.D: Energy in Chemical Processes and Everyday Life**
  - The chemical reaction by which plants produce complex food molecules (sugars) requires an energy input (i.e., from sunlight) to occur. In this reaction, carbon dioxide and water combine to form carbon-based organic molecules and
release oxygen. (*secondary to MS-LS1-6*)

- Cellular respiration in plants and animals involve chemical reactions with oxygen that release stored energy. In these processes, complex molecules containing carbon react with oxygen to produce carbon dioxide and other materials. (*secondary to MS-LS1-7*)

• Crosscutting Concepts:
  • Systems and System Models
    • Models can be used to represent systems and their interactions—such as inputs, processes and outputs— and energy, matter, and information flows within systems. (MS-ESS2-6)
  • Energy and Matter
    • Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. (MS-ESS2-4)

• Science and Engineering Practices:
  • Developing and Using Models
    • Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.
    • Develop and use a model to describe phenomena. (MS-ESS2-1)
    • Develop a model to describe unobservable mechanisms. (MS-ESS2-4)
  • Asking Questions and Defining Problems
    • Asking questions and defining problems in grades 6–8 builds from grades K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.
    • Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles.

Performance Expectations:
• MS-ESS2-4 Develop a model to describe the cycling of water through Earth’s systems driven by energy from the sun and the force of gravity. [Clarification Statement: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.] [Assessment Boundary: A quantitative understanding of the latent heats of vaporization and fusion is not assessed.]

• MS-LS2-3 Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. [Clarification Statement: Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system.] [Assessment Boundary: Assessment does not include the use of chemical reactions to describe the processes.]

Common Core State Standards, English Language Arts and Literacy, Grade 6

• RI.6.7 Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.

• RST.6.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

• SL.6.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others’ ideas and expressing their own clearly.
  • SL.6.1.b Follow rules for collegial discussions, set specific goals and deadlines, and define individual roles as needed.
  • SL.6.1.c Pose and respond to specific questions with elaboration and detail by making comments that contribute to the topic, text, or issue under discussion.
  • SL.6.1.d Review the key ideas expressed and demonstrate understanding of multiple perspectives through reflection and paraphrasing.

• SL.6.2 Interpret information presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how it contributes to a topic, text, or issue under study.

• SL.6.4 Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to accentuate main ideas or themes; use appropriate eye contact, adequate volume, and clear pronunciation.

• SL.6.5 Include multimedia components (e.g., graphics, images, music, sound) and visual displays in presentations to clarify information.

• SL.6.6 Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate. (See grade 6 Language standards 1 and 3 on page 53 for specific expectations.)
• L.6.1 Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.
  • L.6.1.a Ensure that pronouns are in the proper case (subjective, objective, possessive).
  • L.6.1.b Use all pronouns, including intensive pronouns (e.g., myself, ourselves) correctly.
  • L.6.1.c Recognize and correct inappropriate shifts in pronoun number and person.
  • L.6.1.d Recognize and correct vague pronouns (i.e., ones with unclear or ambiguous antecedents).
• L.6.3 Use knowledge of language and its conventions when writing, speaking, reading, or listening.
  • L.6.3.a Vary sentence patterns for meaning, reader/listener interest, and style.
  • L.6.3.b Maintain consistency in style and tone.
• L.6.6 Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases; gather vocabulary knowledge when considering a word or phrase important to comprehension or expression.

Connections to Edible Schoolyard Standards
Edible Schoolyard 3.0
In the Edible Schoolyard Program
• 1.1.0 Students work with each other and teachers to develop community and personal stewardship, along with skills that will help them navigate different situations throughout their lives.
• 1.1.1 – 1.3.12 This lesson fulfills all Edible Schoolyard Program standards, numbers 1.1.1 through 1.3.12. See The Edible Schoolyard Berkeley Standards for details.

In the Garden Classroom, 6th grade
• Concepts 3.3.7 Use observation and awareness to explore, investigate and be inquisitive learners in the garden. The garden classroom provides the opportunity for students to tap into their inherent curiosity about the natural world, observe patterns and connections and understand cause and effect.
• Concepts 3.3.10 Acknowledge water as a precious resource that is intrinsic to all living organisms, explore methods of water conservation, and are encouraged to do the same in their own lives as well.
Carbon Cycle Lesson

Materials
• Clipboards
• Paper
• Pencils
• Colored pencils
• Hang tags with grommets
• Twine
• Two ladders
• Job Board
• G6-11 Visual Aid
• G6-11 Carbon Cycle *sentence frames

Before You Begin
• Gather materials under the Grandmother Oak tree
• Prep clipboards with a piece of paper
• Create the Job Board
• Create the Visual Aid
• Copy Carbon Cycle *sentence frames for each adult leading a group

Timeline Overview
Total Duration: 90 minutes
1. *Invitation* (5 minutes)
2. Application* (60 minutes)
3. Exploration* (5 minutes)
4. Concept Invention* (5 minutes)
5. Application* (5 minutes)
6. Reflection* (5 minutes)
7. Reflection* (5 minutes)

Procedures
At the Opening Circle
(Use the word photosynthesis in a sentence: “Can someone explain how the tree uses photosynthesis?”)

1. Invitation*: (5 minutes)
   Introduce today’s lesson:
   a. Explain to students that they will be studying and celebrating the oldest organism in the garden ecosystem.
   b. Ask students to guess the organism’s identity (Grandmother Oak!).
   c. Explain that each group will take time out of its Garden Work Rotation to visit the Grandmother Oak tree.
   d. Each group will have a chance to learn more about what the Grandmother Oak gives to the garden ecosystem and what she takes from it.
   e. Inform students that the Closing Circle will take place under the Grandmother Oak tree, not in the Ramada.
   f. Invite students to reflect on the role of trees in our garden and in our world during garden class today. Read a poem about trees to set the tone. (We chose a poem – “Prayer to Februus” by Joe Lamb – that our tree company sent to us.)
   g. Go over today’s garden jobs, divide students into 4 working groups, one group for each job, and begin.

In the Field
2. Application*: (60 minutes)
   Each group rotates through At Grandmother Oak as the other groups work in the garden, thinking and talking about Grandmother Oak and the carbon cycle.
   a. The first group jumps to step 3. Exploration* while the other three groups begin their garden work.
   b. When the first group finishes step 6. Reflection*, they return to their Garden Work Rotation and the next group starts Application* step 3.
   c. It takes a total of 80 minutes of class time to get all groups through steps 2, 3, 4, 5 and 6.

At Grandmother Oak (20 minutes total)
3. Exploration*: (5 minutes)
   Gather students in a small circle by the Grandmother Oak for a quick check-in.
   a. Invite students to take a deep breath in and out.
      i. What are they inhaling and exhaling?
      ii. In this moment, they are linked to the Grandmother Oak tree. We will discuss this further in a moment.
b. Tell students that we’ll begin our discussion of Grandmother Oak with a round of modified Think-Pair-Share to complete these sentence fragments about the tree:
   i. I notice...
   ii. I wonder...
   iii. It reminds me of...
   iv. This time, they have one minute to share alternating observations about the tree. When the minute is up, the teacher will yell “Switch” and students will move on to the next question.
   v. To use Think-Pair-Share*:
      1) Think - Give students an interesting broad question to think or write about briefly.
      2) Pair - Pair students, and ask them to discuss the question(s) with their partner.
      3) Share - Students share their discussion ideas with another pair of students or the instructor leads a whole group discussion about the topic.

4. Concept Invention*: (5 minutes)
   Explain to students that now they have warmed up and focused on Grandmother Oak, we are going to spend some time creating a model of her life.
   a. Ask them to take a few minutes to draw this tree’s life story.
      i. How did she get here?
      ii. What has she taken in during her life?
      iii. What has she given to the garden ecosystem?
      iv. Have students take a clipboard, pencil, and piece of paper to create a visual representation of Grandmother Oak’s life.
   b. After five minutes, bring the students back together and have them share the models they created. Some questions might be:
      i. What has Grandmother Oak taken in from her environment during her life?
      ii. What has Grandmother Oak given to her environment?
      iii. What do your models have in common? What is different?
      iv. Why did you decide to represent Grandmother Oak’s life in the way you did?
      v. From what knowledge and experiences did you draw?

5. Application*: (5 minutes)
   Direct students to the Grandmother Oak Visual Aid.
a. Give students a chance to look at the poster.
b. Ask what similarities and differences in content (not style) they see between the poster and their models.
c. Ask students to walk the group through the life cycle represented on the poster.
d. Ask students to trace the flow of carbon through the tree's life.
e. If there is time, have students read the timeline (starting at the present and working backwards) and reflect on what the Grandmother Oak has seen in her lifetime.
   i. Discuss the connection between the start of the Industrial Revolution and the importance of trees.

6. **Reflection*: (5 minutes)
   Ask students to reflect on all they have learned and observed about Grandmother Oak and her contribution to our garden system.
   a. Invite students to write out an appreciation for the tree on a hangtag using colored pencils. Some examples are:
      i. I appreciate Grandmother Oak for giving us clean air to breathe.
      ii. Thank you Grandmother Oak for your beauty and strength.
   b. Tie each hangtag to a long piece of twine.
   c. Let the students know that they'll hang up their appreciations at Closing Circle.
   d. Return the group to their Garden Work Rotation and ring the bell to signal the next group.

**At the Closing Circle** (Under Grandmother Oak tree)

7. **Reflection*: (5 minutes)
   Gather students in a circle under the Grandmother Oak.
   a. Invite a few students to share their appreciations for Grandmother Oak.
   b. Using two ladders, have students hang their class's appreciations from branches in the tree.

**Vocabulary**
Carbon cycle
Life cycle
Photosynthesis
Acorn
Sapling
Sprout
Contributors
All lessons at the Edible Schoolyard Berkeley are developed in collaboration with the teachers and staff of the Edible Schoolyard and Martin Luther King Jr. Middle School.

Learning Cycle and Think-Pair-Share discussion routine © The Regents of the University of California. All materials created by BEETLESTM at The Lawrence Hall of Science.

Resources
G6-11_Visual_Aid.pdf
G6-11_Grandmother_Oak_TPS.pdf
OUR GRANDMOTHER OAK
(CALIFORNIA/COAST LIVE OAK or quercus agrifolia)

THE CHOCHENYO/HUICHON BAND OF OHLONE RELIED ON THE OAK'S ACORNS (FORGED OR GROUND) AS AN IMPORTANT FOOD SOURCE

EUROPEAN SETTLERS FIRST ARRIVE IN BERKELEY (THE DE ANZA EXPEDITION)

GRANDMOTHER OAK WAS BORN SOME TIME AROUND HERE (SHE COULD LIVE FOR OVER 250 YEARS!)

1760

START OF INDUSTRIAL REVOLUTION: BURNING OF FOSSIL FUELS

1796

LIFE CYCLE

ENERGY (LIGHT)

LIGHT

CO2

O2

LIFE CYCLE

LIFE CYCLE

CARBON DIOXIDE (CO2) + WATER (H2O) \rightarrow LIGHT \rightarrow CARBOHYDRATES/GLUCOSE (C6H12O6) + OXYGEN (O2)

PHOTOSYNTHESIS

ACORN/SEED

SPROUT

SAPLING

MATURE OAK

DEAD TREE

WOOD/FUEL

PLANTS SEEDS

CARBON DIOXIDE (CO2)

WATER (H2O)

CARBOHYDRATES/GLUCOSE (C6H12O6)

OXYGEN (O2)

NUTRIENTS

NUTRIENTS

DECOMPOSITION (FBI)

ASHES

NUTRIENTS (CARBON)

YOU'RE IN GARDEN CLASS!

THE EDIBLE SCHOOLYARD WAS FOUNDED (ON OLD SCHOOL PARKING LOT)

1968

1996

1909

1922

1878

1841-1842

1769-1776

1968

UC: CIVIL WAR

CITY OF BERKELEY

GARFIELD JR. HIGH ESTABLISHED ON THIS CAMPUS

TOWN OF BERKELEY BECAME CITY OF BERKELEY

TOWN OF BERKELEY

2016

THE CHOCHENYO/HUICHON BAND OF OHLONE RELIED ON THE OAK'S ACORNS (FORGED OR GROUND) AS AN IMPORTANT FOOD SOURCE
1) How did she get here?

2) What has she taken in during her life?

3) What has she given to the garden ecosystem?