NATIONAL GEOGRAPHIC

RESOURCE LIBRARY I ACTIVITY : 1 HR 40 MINS

Matter and Energy Cycles: Modeling

In teams, students utilize their research to create a model of their assigned cycle (water cycle, rock cycle, or photosynthesis and respiration) and then leverage that model to teach other groups what they learned in a jigsaw-style activity. Finally, the whole class creates a new draft of the carbon cycle by integrating the new cycles into their previous draft.

GRADES

6, 7, 8

SUBJECTS

Earth Science

CONTENTS

2 PDFs

OVERVIEW

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For the complete activity with media resources, visit:
http://www.nationalgeographic.org/activity/matter-and-energy-cycles-modeling/

In collaboration with

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DIRECTIONS

This activity is part of the Carbon Trackers unit.

1. Tell students that they will be sharing information and building a visual model of the cycle or processes they researched in the *Matter and Energy Cycles: Research* activity. Show them two videos on the power of models to kick off the activity.

- Begin with the short video on *Models in Marine Science* (the first video linked on the page), and follow directly with the second video on the page, *Models in Science*.
- Ask students to use the Think-Pair-Share model to answer the following questions:
    - *What is a scientific model?* (Correct response based on content of the videos: In science, a model is a representation of an idea, an object, or even a process or a system that is used to describe and explain phenomena that cannot be experienced directly.)
    - *How and why are models used in science?* (Correct response based on content of the videos: Models have a variety of uses—from explaining complex data to presenting a hypothesis. Models are a visual way of linking theory with experiment. They guide research by being simplified representations of reality that enable predictions to be developed and tested by experiment. Emphasize for students the point that models are simplified versions of the real world, and that there are assumptions involved in working with a model.)
    - *Can you think of an example of a scientific model not featured in the videos?* (Possible student responses include: scale solar system model, model of a human body, weather map on TV, model of an atom.)

2. Ask each team to use what they learned in the *Matter and Energy Cycles: Research* activity to create a more polished visual model of the cycle they have been assigned (water cycle, rock cycle, or photosynthesis and respiration).

- These may be very similar to the sketches they produced in the previous activity (on their *Researching Earth's Cycles* handout), but this is the time to finalize them to be shared with the other groups that researched the other cycles. These may also be used to present to the final audience in Lesson 3, *Educate to Inspire.*
- Briefly review the terms from the introduction to systems thinking processes (ways that matter or energy is transferred between reservoirs) and reservoirs (where matter or energy is stored).

- Present and explain the *Cycle Model Rubric* so students have a general understanding of the criteria for the models and presentation. The rubric can be used to evaluate their presentations now (though the model they are creating in this activity will only be a sub-cycle, and not the full carbon cycle) and in the final presentation in Lesson 3.
- The model should contain all relevant processes of their assigned cycle (water cycle, rock cycle, or photosynthesis or respiration), arrows showing which way flow or exchange happens, clear labels with correct scientific terms, and be visually organized and appealing to help others understand the cycle. Energy should be shown moving through the cycle, where relevant and possible, in one color, and needs to be indicated on a legend or key off to the side. If needed, use examples from the *Tracking Down the Carbon* activity to refresh their memory of the processes).
- It can be created by hand with paper, colored pencils, or using digital tools, depending on your students' experience and your access to technology.
- Allow about 15 minutes for students to create their visual models.
- As students work, circulate through the teams to support their collaboration, clarify ideas, and encourage creativity.

3. Prompt each team to present their model to the rest of the class, giving each team roughly five minutes to present.

- You may choose to use the rubric at this point to evaluate students' sub-cycle model and their presentation skills for this section. The rubric will be used again when they present a smaller piece in the class presentation for the final project, but this is a good test run of using it with each person and small group.
- The rest of the class should use the presentation to complete the relevant portion of the *Researching Earth's Cycles* handout as they listen, with particular attention paid to the sketch section where they should draw, as much as possible, the model the presenting team is showing.
- After all teams have presented their models, jigsaw the groups such that you have at least one representative from each team in a mixed group. Provide them with five extra minutes to compare their research handouts and correct errors or fill in missing pieces.

4. Have students collaborate to link their cycles into a larger carbon cycle model.

- Display the collaborative initial carbon cycle model generated in the *Tracking Down the Carbon* activity and focus on the question marks or missing pieces. Students will now use the new cycle models they have made to address those areas.

    - Have students work in the mixed groups that they formed at the end of Step 3 so that each group contains at least one representative from each sub-cycle.
    - Explain that their new assignment is to integrate the details and new information about the three models into the initial carbon cycle model (developed in the *Tracking Down the Carbon* activity). Emphasize that this is now a third draft of the initial carbon cycle model and the first draft of one that will be used in their final presentation to educate an outside audience, so it needs to be visually appealing and easy to interpret.

- Carefully evaluate which reservoirs and processes involve carbon or energy movement directly, and which don't. For example, the processes from the hydrologic cycle, precipitation, and evaporation aren't ways that carbon is moved, so they may be dropped from this final model because they aren't a major component of the carbon cycle itself.
- Distribute the *Cycle Model Rubric* and thoroughly review the target example so that students understand the criteria by which their revised carbon cycle model and presentation will ultimately be assessed.
- Prompt students to collaborate to create their new integrated model, giving them about 25 minutes.

Announce that teams will now share their models through a gallery walk, and then collaboratively decide upon the key features needed for their final version.

- Display each team's cycle model on the wall or on desks, and have the teams rotate through to look at the other team's models, giving them about five minutes with each.

    - Ask students to write down on sticky notes at least three strengths and three areas for improvement for each model and leave the feedback on the wall or desk near that model.

- Follow up with a class discussion. Hold up each team's model and read aloud some of the strengths and areas of improvement, asking for elaboration when needed. Ask: *What strategies did you see that were particularly effective at integrating the sub-cycles with the carbon cycle?*
- Record responses, which will help the class create the final model in the *Final Carbon Cycle Model Creation* activity.
- Ask students if they have any other ideas to think through, add, or investigate further to ensure their final class model is complete and clear. Record any questions or research avenues for later use in the *Final Carbon Cycle Model Creation* activity.

Tip

Step 2: You may also choose to engage students in adding additional criteria to the rubric.

Tip

Step 4: If you are generating digital models, be sure to have computers for each team for this activity.

Tip

Step 4: Some groups may want to start over entirely using large poster paper or butcher paper versus adding onto the initial models. It may help to have supplies like sticky notes, scissors, paper, pens/markers, masking tape, etc., to help them creatively start to link the models. The act of physically creating the rough draft of their model will help students to generate ideas.

Tip

Step 4: Students need to have printed copies of the carbon cycle model they generated in the *Tracking Down the Carbon* activity, as well as the other three models at hand to use for this step.

Rubric

Collect the models that each team creates of their assigned cycle (rock cycle, water cycle, or photosynthesis and respiration) and use the *Cycle Model Rubric* to assess the team's understanding.

OBJECTIVES

Subjects & Disciplines

- **Earth Science**

Learning Objectives

Students will:

- Understand the detailed parts and processes of the water cycle, the rock cycle, and photosynthesis and respiration.
- Collaborate with a team to create an informative model of a cycle and use it to teach peers about that cycle.

Teaching Approach

- Project-based learning

Teaching Methods

- Cooperative learning
- Discussions
- Jigsaw

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Learning and Innovation Skills
    - Communication and Collaboration
    - Creativity and Innovation
    - Critical Thinking and Problem Solving
  - Life and Career Skills
    - Flexibility and Adaptability
    - Leadership and Responsibility
    - Productivity and Accountability
    - Social and Cross-Cultural Skills
- 21st Century Themes
  - Environmental Literacy
  - Global Awareness
- Science and Engineering Practices
  - Developing and using models

- Obtaining, evaluating, and communicating information

National Standards, Principles, and Practices

COMMON CORE STATE STANDARDS FOR ENGLISH LANGUAGE ARTS & LITERACY

• **CCSS.ELA-LITERACY.SL.7.1:**
Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on Grade 7 topics, texts, and issues, building on others' ideas and expressing their own clearly.
• **CCSS.ELA-LITERACY.SL.7.4:**
Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation.

NEXT GENERATION SCIENCE STANDARDS

• **Crosscutting Concept 4:**
Systems and system models
• **Crosscutting Concept 5:**
Energy and matter: Flows, cycles, and conservation
• **ESS2.A: Earth 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.
• **ESS2.C: The Roles of Water in Earth's Surface Processes:**
Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. (MS-ESS2-4)
• **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)

• **MS-ESS2-1:**

Develop a model to describe the cycling of Earth’s materials and the flow of energy that drives this process.

• **MS-LS2-3:**

Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.

• **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)

• **Science and Engineering Practice 2:**

Developing and using models

• **Science and Engineering Practice 8:**

Obtaining, evaluating, and communicating information

Preparation

What You'll Need

MATERIALS YOU PROVIDE

- Computer and access to design software (if you are choosing to create digital models)
- Copies of the *Cycle Model Rubric* for each team to review
- Large pieces of paper (11 x 14), butcher paper, or poster-size paper
- Printed copy for each team of the collaborative initial carbon cycle model generated in the *Tracking Down the Carbon* activity
- Sticky notes

REQUIRED TECHNOLOGY

- Internet Access: Optional
- Tech Setup: 1 computer per learner, Projector

PHYSICAL SPACE

- Classroom
- Computer lab

SETUP

Ideally, tables or desks should be grouped together to help facilitate team collaboration on the visual model.

GROUPING

- Jigsaw grouping
- Large-group instruction
- Large-group learning

RESOURCES PROVIDED: UNDEFINED

- Science Learning Hub: Models in Science
- Science Learning Hub: Models in Marine Science

RESOURCES PROVIDED: HANDOUTS & WORKSHEETS

- Researching Earth's Cycles
- Cycle Model Rubric

BACKGROUND & VOCABULARY

Background Information

The global carbon cycle is the way that carbon moves through various reservoirs on Earth. There is a slower part of the carbon cycle and a faster part of the carbon cycle. Understanding how carbon moves in these two cycles requires knowledge of other sub-cycles and processes, namely photosynthesis and respiration, the rock cycle, and the water cycle.

The slow carbon cycle moves carbon through the lithosphere, atmosphere, and hydrosphere over 100- to 200-million-year timescales, primarily through the processes of the rock cycle. The fast carbon cycle moves carbon from the atmosphere into the biosphere via photosynthesis in

plants and phytoplankton. It can then move back into the atmosphere if the plant matter is burned, the plants die and decay via bacterial processes, the plants are eaten by animals or people and carbon is released into the atmosphere as a product of digestion, or it is exhaled through the process of respiration.

Prior Knowledge

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Recommended Prior Activities

- Matter and Energy Cycles: Research
- Putting the "Fossil" in Fossil Fuels
- Researching Fossil Fuels
- Tracking Down the Carbon

Vocabulary

Term	Part of Speech	Definition
condensation	*noun*	process by which water vapor becomes liquid.
erosion	*noun*	act in which earth is worn away, often by water, wind, or ice.
evaporation	*noun*	process by which liquid water becomes water vapor.
hydrologic cycle	*noun*	system of recycling liquid, gas, and solid water throughout a planet. Also called the water cycle.
photosynthesis	*noun*	process by which plants turn water, sunlight, and carbon dioxide into water, oxygen, and simple sugars.
precipitation	*noun*	all forms in which water falls to Earth from the atmosphere.
respiration	*noun*	breathing.
rock cycle	*noun*	processes that explain the relationship between the three rock types: igneous, sedimentary, and metamorphic. Any rock type can become any other.
sedimentation	*noun*	process of accumulating small solid deposits.
sublimation	*noun*	the process by which snow or ice becomes water vapor without first melting and passing through the liquid phase.
weathering	*noun*	the breaking down or dissolving of the Earth's surface rocks and minerals.

For Further Exploration

Images

- National Geographic: Water Cycle
- National Geographic: The Rock Cycle
- National Geographic: Photosynthesis

Instructional Content

- Exploratorium: Follow the Carbon