

Climate 101 Week 7

Deeper into the Carbon Cycle

Overview of the Week

- * Analyze the flows of carbon into and out of the atmosphere based on the PCEP Interactive: *Carbon Dioxide and the Carbon Cycle*
- * Using *Ocean Science Sequence Unit 2*, investigate respiration and photosynthesis, and their roles in the carbon cycle

Before Teaching this Week:

- * Print for each participant a Unit 2 Student Investigation Notebook.
- * Review these instructions, the slides in the power point, all handouts, and the Teacher's Guide description of Session 2.2 and Session 2.3. Slides 1 through 13 (Day 1) have notes embedded with the slides that you may find very useful.
- * Make color copies of the t
- * Make copies of "My Carbon Cycle Hypotheses" for each participant for Day 1
- * Prepare balloons and other materials for balloon carbon cycle activity,
- * Print for each participant the simplest Carbon Cycle Diagram from the Unit 2 Copymaster Packet (page 11). You should have extra copies for participants who get stuck and want to start over in drawing their initial model of the carbon cycle.
- * Prepare all materials and handouts for the Yeast Investigation; the BTB Jar with Plant Activity; and Tracking Carbon Through Photosynthesis Part 1.
- * Optional: practice the BTB Jar with Plant activity with additional controls (see end of Day 2), and document results with photos.
- * Prepare envelopes that have all three strips of evidence related to the source of plant matter. This is from Unit 2 Copymaster 2.3 Student Sheet with information about Plant Investigations B, C, and D as part of Session 2.3 (Day 3).

Day 1: "Carbon Flows into and out of the Atmosphere"

Show Slide 1 (Carbon Dioxide and the Carbon Cycle). Remind participants about the PCEP Carbon Cycle Interactive that they explored in the previous session. Very briefly review the different reservoirs. Highlight that we are analyzing the flows of carbon between the atmosphere and the ocean, and between the atmosphere and Land Biomass. (the main component of the biosphere carbon reservoir). Solicit any questions that they may have based on their experience with the interactive. Note the questions and any particularly interesting comments on posted chart paper. Do not answer the questions, especially if the upcoming sessions will provide relevant information to answer the questions.

Show Slides 2 through 5 as a way to elicit and deepen participant understanding of the processes that move carbon into and out of the Land Biomass reservoir and the Ocean reservoir. Participants can participate individually or in pairs to suggest wording for each of the blank boxes.

Give each participant a copy of the “Carbon Cycle Hypotheses” handout. **Show Slides 6 and 7** to guide them into individually making their hypotheses for changes in the three Earth systems 300 years ago. **Show Slides 8 through 10** to guide their individual hypotheses for changes in the three Earth systems in the present day.

Show Slide 11 (CO₂ in the Atmosphere: Changes Since the Year 1000). Explain that the x-axis goes from the year 1000 to about 2010, and that the y-axis expresses the concentration of carbon dioxide in the atmosphere in terms of parts per million (ppm). For reference 275 ppm (the concentration about 300 years ago) corresponds to a concentration of 0.0275%. Solicit their interpretations of how carbon dioxide was or was not changing in the atmosphere 300 years ago (mostly staying the same) and in the present day (increasing).

Have participants share their hypotheses about the other changes on their handout. Include discussion about their evidence (based on the interactive) and reasoning. If there are significant differences in the hypotheses, refer to the interactive charts (Slides 6 and 9) to help reach a class consensus.

Show Slide 12 (Temperature and CO₂ Over the Past 1000 Years). Note that there seems to have been some cooling with a lot of variation between 1000 and the start of the Industrial Age. The rapid increase in carbon dioxide over the century clearly correlates with the rapid increase in carbon dioxide in the atmosphere. This correlation is what we commonly refer to as human-caused global warming.

Show Slide 13 (Climate Change: Causes and Impacts) and explain that this slide summarizes many of the concepts that we will be exploring in the rest of the course. Part of last week and all of this week focus on the parts in black (namely, the carbon cycle). The part in red involves how the increased carbon dioxide in the atmosphere causes global warming. The parts in blue involve how global warming and the increased amount of CO₂ in the ocean cause climate change impacts that can significantly harm ecosystems and human communities. The blue part also includes actions communities can do to reduce the damages caused by climate change.

Day 2: Session 2.2: “Tracking Carbon through Respiration”

Give each participant a copy of the Unit 2 Investigation Notebook at the start of the session. **Show Slide 3 (Photosynthesis/Respiration)** as a reminder that we are focusing on the carbon cycle this week. Ask questions to elicit comments that help elicit comments that respiration/decomposition is a very important flow of carbon dioxide into the atmosphere from plants and animals, and that photosynthesis is a very important flow of carbon dioxide out of the atmosphere into plants.

Show Slides 14 through 20 while generally following the Teacher Guide instructions for Ocean Sciences Sequence Session 2.2. You may want to do a quick demonstration to provide a stronger connection between the BTB colors and the acid-base continuum. This demonstration would involve adding drops of ammonia (a very common base) to a BTB solution in a flask to turn it deep blue. Then drop-by-drop, you can add vinegar (a common

acid) to the solution, and show the transition from deep blue (basic) to green (neutral) to yellow (acidic).

Show Slide 21 (the simplest Carbon Cycle Diagram in the Copymaster file). Each participant makes a carbon cycle model diagram. They could use the PCEP Carbon Cycle Interactive as a model, the version shown on this slide that is part of the *Ocean Science Sequence* Unit 2, or a different model of their own creation.

Set up the BTB Jar with Plant Activity with the result to be shared at the next class session. Explain this setup and have a discussion about what might happen and why.

If there is time, you can lead the carbon cycle balloon demonstration to show another way to teach and learn about the flows of the carbon cycle. In addition or alternatively you can show the Studio Version of the Carbon Cycle on the *Dr. Art Does Science* DVD.

Day 3: Session 2.3: "Tracking Carbon through Photosynthesis, Part 1"

Show Slides 22 and 23 to introduce the session. If the BTB Jar with Plant had the BTB turn blue, show that jar or appropriate photos of it in conjunction with Slide 22. Have participants discuss what caused that result, and then share via whole class conversation.

If desired, do an optional activity to help teach about science investigation practices and the nature of photosynthesis. With class, describe the major steps in the BTB Jar Photosynthesis activity (BTB solution acidified with carbon dioxide; plant leaf inserted; jar exposed to sunlight; observe for any color change). Have participants work in groups to design a control for this experiment that would strengthen the conclusion that the resulting change in color is due to photosynthesis and not other causes. Have groups share with each other, and then via whole class discussion, decide what experiments volunteers could try before the next class session. Possible variables to control include acidifying with vinegar and not carbon dioxide; no exposure to sunlight (keep in dark, or cover jar); nothing inserted or substitute non-photosynthesizing material.

Show Slides 24 through 27 in sequence with the instructions in the Teacher's Guide. If you have access, show the brief photosynthesis video from PBS Learning Media (go to pbslearningmedia.org and search for NOVA/Photosynthesis). Facilitate the participant analysis of evidence about the major source of plant matter from Plant Investigations B, C and D.

Include one or both of the two optional readings that are in the Unit 2 Investigation Notebook (pages 10-13): *Researching Photosynthesis* and *Kelp: Giant Forests of the Sea*. Use different literacy strategies depending on the participants' English Language Literacy. Conclude by reviewing the evidence that most of the matter in plants comes from carbon dioxide gas in the air.

Homework Assignment is to write about our Two Guiding Reflections (same questions used at the end of every week):

- 1) Choose a concept of activity from this week. How would you teach this concept or activity with your students?
- 2) What would be hard for your students to understand about this concept or activity?