

Carbon Loop Lab

Develop and test a model across four Earth spheres.

HS-LS2-5 "Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere..."

NAME _____

DATE _____

1 READ AND MARK _____ Read it twice

YOUR JOB Read the aquatic-system notes. Circle the four spheres and underline what photosynthesis and cellular respiration do to carbon. Then construct your own model on the blank canvas.

Carbon in a Shallow Coastal System

- ① This simplified system contains air above the water (atmosphere), dissolved carbon dioxide in water (hydrosphere), living organisms (biosphere), and organic carbon stored in bottom sediments (geosphere). Sunlight supplies energy, not carbon atoms. Photosynthetic organisms use dissolved carbon dioxide to build organic molecules. Animals obtain organic carbon by feeding; feeding moves carbon within the biosphere.
- ② Photosynthetic organisms, animals and decomposer microbes all perform cellular respiration. They break down organic molecules and release carbon dioxide; in this aquatic system it enters the water. Carbon dioxide also moves in both directions between water and air through gas exchange. Organisms can photosynthesize and respire; assigning respiration only to animals would miss an important route.
- ③ Dead material and waste can settle into sediments. Decomposer microbes can take up carbon from accessible organic material there and release some as carbon dioxide through respiration. Some sediment carbon remains stored or becomes buried for long periods. This model leaves out many pathways, including deep-ocean transport and rock weathering. It tracks carbon transfers, not all chemical steps or the complete energy budget.

2 ANSWER WITH EVIDENCE _____ Use the passage

- 1** Compare photosynthesis and cellular respiration as transfers between water and living organisms.

- 2** How could a carbon atom stored in accessible sediment organic matter return to a photosynthetic organism? Name the processes.

- 3** In an invented one-hour calculation, photosynthesis transfers 10 carbon units from water to living organisms, while respiration returns 8. Ignore every other transfer. What is the net change in each store?

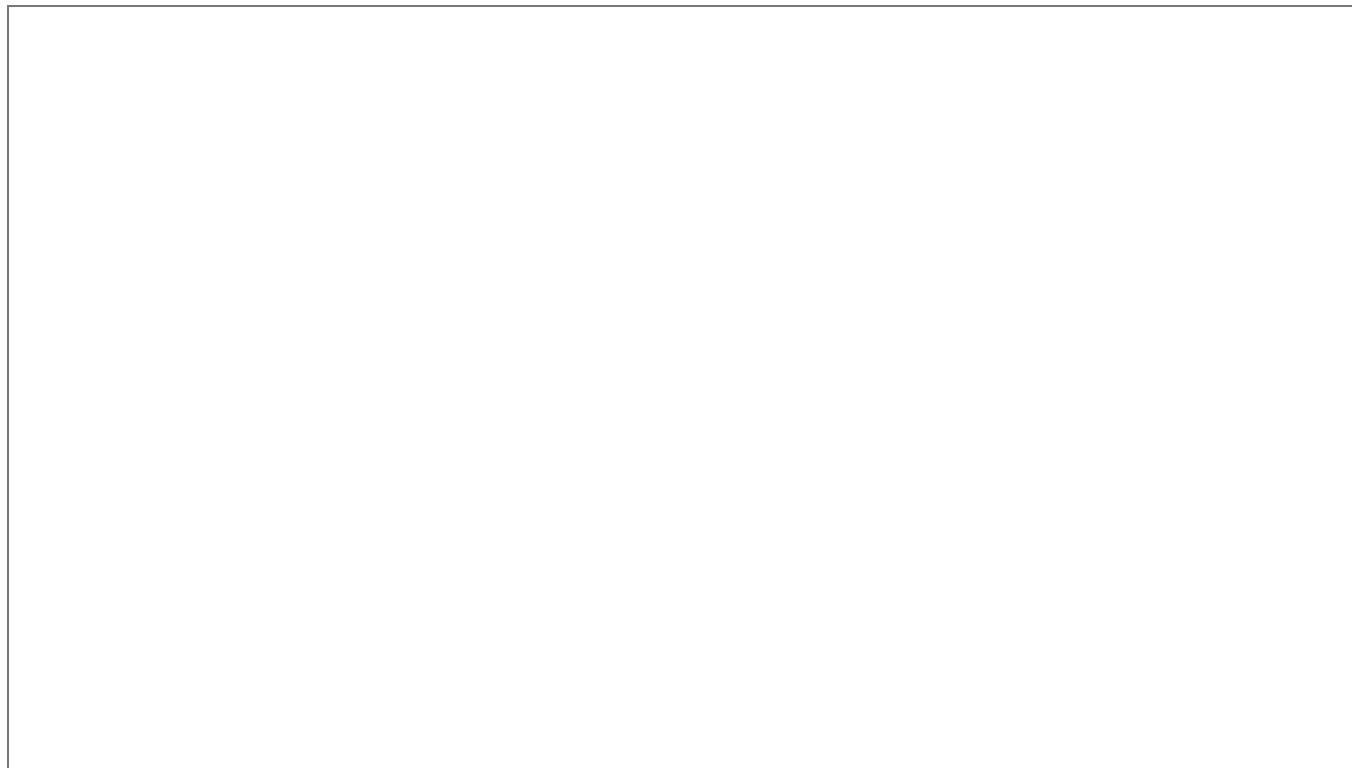
- 4** For another modeled hour in darkness, set photosynthesis to 0 and keep respiration at 8 units. Still ignore every other transfer. What changes, and why is this a limited prediction?

3 YOUR TURN _____ Your own words

Develop a carbon-transfer model from the reading. Choose the placement of stores and routes yourself; the example diagram is on the teacher key only.

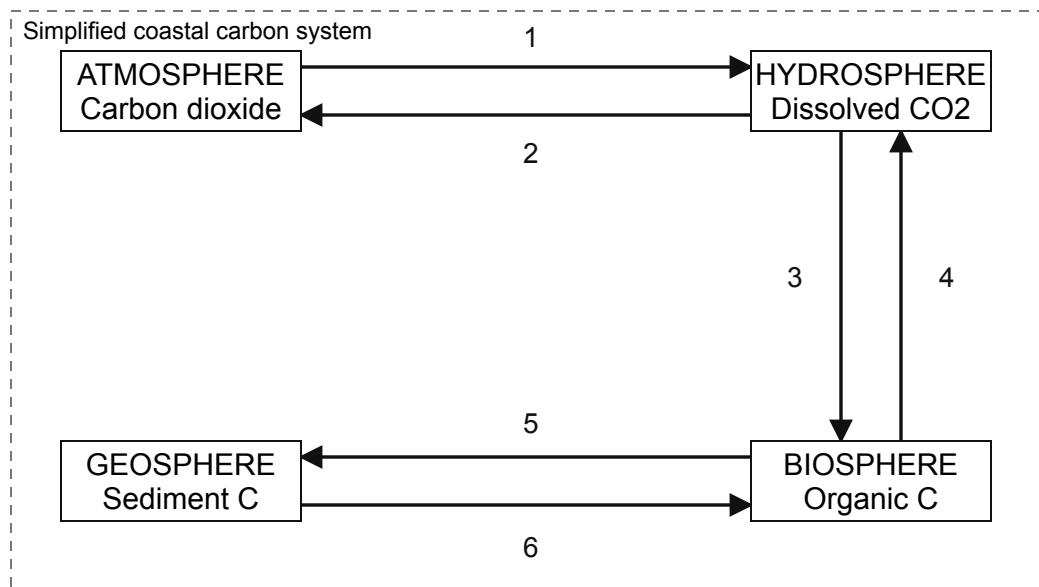
Build, trace, and critique

Arrange and label all four spheres and their carbon stores. Identify producers, animals and decomposer microbes within the biosphere. Draw directed arrows for photosynthesis, respiration, air-water exchange, settling of dead material/waste and decomposer uptake from sediment. Show or note feeding within the biosphere. Label each process; do not draw sunlight as a source of carbon. Trace one possible route linking all four spheres, then explain one limitation below.



Explain how your route conserves carbon and one way this model simplifies the real system.

Build, trace, and critique · example model



1: CO₂ dissolves from air into water. 2: CO₂ leaves water for air. 3: photosynthesis builds organic carbon. 4: cellular respiration returns CO₂ to water. 5: dead material/waste settles into sediment. 6: decomposers take up accessible sediment organic carbon. The biosphere box includes producers, animals and decomposer microbes; feeding transfers carbon within it. Some sediment carbon stays stored. The arrows show possible transfers, not equal rates.

1. Photosynthesis transfers dissolved carbon into organic molecules in photosynthetic organisms. Respiration returns some organic carbon as carbon dioxide to water. Photosynthetic organisms also respire.
2. A decomposer takes up organic carbon, then respiration releases it as carbon dioxide to water. Photosynthesis can put that carbon into a producer's organic molecules. Not all buried sediment carbon returns quickly.
3. Living organisms gain 2 units; water loses 2. The combined total is unchanged. These invented numbers are not measured ecosystem rates.
4. Living organisms lose 8 units and water gains 8. Darkness removes the modeled photosynthesis input while respiration continues. Real rates and other transfers vary; the fixed-rate, two-store calculation is a simplifying assumption.

PART 3 · YOUR TURN (SAMPLE ANSWER)

A valid route is air to water by gas exchange, water to living producers by photosynthesis, living matter to sediments through settling, sediment organic matter to decomposers by uptake, and respiration back to water before gas exchange to air. Not every atom follows this route or returns quickly.

Require all four spheres, carbon forms, directed process arrows, both photosynthesis and respiration, and a pathway involving sediments. Living microbes belong to the biosphere even when they live in sediment. Grouping organisms in one box is acceptable if producers, animals and decomposers and feeding within that box are explained. Do not require arrow thicknesses or rates not supplied. Credit: instructional synthesis of NOAA, Basics of the Carbon Cycle (gml.noaa.gov/outreach/carbon_toolkit/) and What is the carbon cycle? (oceanservice.noaa.gov/facts/carbon-cycle.html).