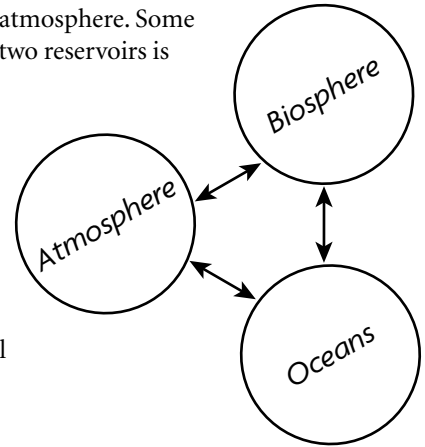


Carbon Cycle

Molecules containing carbon regularly flow between reservoirs as part of the carbon cycle. Carbon from a plant may flow to the atmosphere, from the atmosphere to the ocean, and from the ocean into sediments and eventually into rocks. Some of this flow happens in seconds, for example from a plant to the atmosphere. Some takes much longer, such as sediments turning to rock. The exchange of carbon between two reservoirs is referred to as a **flux**.

The total amount of carbon on earth, including that in the atmosphere, biosphere, and oceans, does not change. However, the amount of carbon in each reservoir does change, and changing the amount of carbon in a reservoir can impact the ecosystems that depend on it. Currently most rapid fluxes of carbon occur between the atmosphere and two reservoirs: the biosphere and the oceans (including the water and the biomass). The biosphere is composed of all living organisms on land. Biomass refers to all living organisms in an area, such as the ocean. The burning of fossil fuels also adds to the carbon in the atmosphere, but it takes hundreds of millions of years for geological process to produce new fossil fuels and return carbon to fossil fuel reservoirs.



Procedure:

1. Make a data table in your science notebook like the one below.

Reservoir name	Pre-industrial	Post-industrial
Rocks		
Soil and detritus		
Land plants		
Atmosphere		
Fossil fuels		
Ocean waters		
Ocean biomass		

2. Start in the “Learn” section of the simulation. Work with your partner to explore the reservoirs and fluxes that are part of the carbon cycle. The amount of carbon is measured in Gigatons. A Gigaton (Gt) equals one million tons. Note that you will have to click on each star and circular arrow to read all of the information before you can move from the pre- to the post-industrial era. Record in your data table the answers to the following questions about the pre- and post-industrial eras:
- How much carbon is contained in the reservoir?
 - How does the reservoir cycle carbon? How much carbon does it cycle?
 - Have humans altered this reservoir? If so, how?

(continued on next page)

Carbon Cycle (continued)

3. When you have finished investigating the pre- and post-industrial eras, proceed to the simulation for the pre-industrial era. The simulation controls are preset to show the estimated level of carbon exchange during the pre-industrial era.
4. With your partner, simulate what happens when you change the amount of photosynthesis and cellular respiration occurring in the biosphere. Run the simulation at least three times, altering the variables each time. For example, if you adjust the photosynthesis variable up by 0.5 Gt, try adjusting the cellular respiration variable up by the same amount, then down by the same amount. For each simulation you run record in your science notebook the settings you chose, and sketch the graph that results.
5. With your partner, discuss how the graphs you recorded for the pre-industrial era simulation differ. Answer the following questions in your discussion:
 - a. What happened to the amount of carbon in the atmosphere, biosphere, and oceans in each simulation run?
 - b. For each simulation run, is the flux of carbon sustainable? Why or why not?
 - c. Try to estimate at what amount the variables would need to be set to provide the most sustainable scenario.
6. Run the pre-industrial simulation one more time, applying your estimates from Step 5.
7. Proceed to the post-industrial era simulation, and repeat Steps 3 through 6. Each time compare the post-industrial data to the pre-industrial data.
8. Discuss with your partner the similarities and differences between the pre- and post-industrialization eras. Summarize your conclusions in your science notebook. Include the following questions in your discussion:
 - a. What kinds of changes, if any, affect each reservoir in the two eras?
 - b. How is the overall carbon cycle different in the two eras?
 - c. What kind of changes would be needed, if any, to maintain a sustainable flux of carbon in each era?