Education and Research: Testing Hypotheses

Lesson Plan—The Biological Pump

Summary

This Web slide show will take students step-by-step through the processes that are involved the biological pump. Students will be encouraged to think about how the pump will react to various changes in the environment, and how availability of nutrients such as nitrate and iron affect the amount of carbon dioxide that is eventually sequestered in the deep oceans.

Key Concepts

- Plants use the energy in light to make sugars out of carbon dioxide and water. Organisms that eat plants break down the plant structures to produce the materials and energy they need to survive. Then they are consumed by other organisms.
- Over a long time, matter is transferred from one organism to another repeatedly and between organisms and their physical environment. As in all material systems, the total amount of matter remains constant, even though its form and location change.
- The amount of life any environment can support is limited by the available energy, water, oxygen, and minerals, and by the ability of ecosystems to recycle the residue of dead organic materials.
- The chemical elements that make up the molecules of living things pass through food webs and are combined and recombined in different ways.

Objectives

Students will be able to:

- ***Describe*** the concept of the biological pump
- ***Explain*** how the biological pump will react to various changes in the environment, and how availability of nutrients such as nitrate and iron affect the amount of carbon dioxide that is eventually sequestered in the deep oceans

Materials

- Computers with Internet access
- Questions for discussion

Procedure

1. Have students log on to the EARTH Web site Iron Fertilization page (http://www.mbari.org/education/EARTH/Iron/iron.htm) and go through the "Biological Pump" online slide show.
2. Discuss follow-up questions as a group, or have students discuss questions in small groups.

Discussion Questions

- What are the primary factors regulating phytoplankton growth?
- If the net flux of biologically-produced materials is one way (from the surface to the deep ocean), how do the nutrients find their way back to the surface waters to refuel the pump?
- What is the sensitivity of the biological pump to environmental changes (upwelling, dust and iron deposition, El Niño)?
- How does the efficiency of the biological pump differ between biogeographical provinces?
- What factor(s) are responsible for the inefficiency of the biological pump in "high-nutrient, low-chlorophyll" (HNLC) waters? Why can't the phytoplankton in these areas use up the nutrients, as they do so effectively in the other regions of the world's oceans?

Assessment

- **Performance**—Did student participate in discussion sessions and demonstrate an understanding of the concept of the biological pump? Was student able to successfully explain how the biological pump will react to various changes in the environment, and how availability of nutrients such as nitrate and iron affect the amount of carbon dioxide that is eventually sequestered in the deep oceans?