The Carbon Cycle: Biological Processes to Societal Implications

By Catherine Borgard

Project Overview

*The Carbon Cycle: Biological Processes to Societal Implications*

The goal of this project was to improve students understanding of the carbon cycle on a global scale. Using hands-on experiments and data from the science community students will be able to generate, interpret and communicate their findings. The current biology curriculum covers photosynthesis and organisms but mostly excludes carbon, climate change and global warming. Here students will experience in an engaging way the connections between carbon removal from water and air, how ocean stratification affects this recycling, and how an imbalance in the short and long cycles can affect the entire planet. Students will also present possible local solutions and present their findings.

RET I - Research (Summer 2013)

I had an exciting opportunity to participate in research that studied the effects of The Deepwater Horizon oil spill in the Gulf of Mexico. Dr. Uta Passow’s research included analyzing phytoplankton, *Thalassiosira weissflogii*, that had been contaminated with oil from the spill and formed a “marine snow blizzard” which had never before been witnessed. Uta Passow’s research is focusing on the global carbon pump and how this tragic event might influence it. The growth of phytoplankton, where different limiting factors were manipulated, have a direct application to the study of photosynthesis, the carbon cycle, and human influences on that cycle in biology classrooms.

RET II - Project Rationale (Summer 2014)

The Next Generation Science Standards (NGSS) for high school life science are exemplified in the following lessons, experiments, and activities. Prior attempts to engage students to “think” through a problem have been disappointing, if not frustrating. Students expect provided choices to select an appropriate answer. The real world does not operate in this fashion and with the crosscutting concepts presented hopefully they will be more successful. The students are expected to take their experimental data and extrapolate the process by which plants gain mass. Students are expected to interpret current scientific data on atmospheric CO2 and graph the results. Students are expected to engineer solutions to real time global issues and present their findings. These goals are necessary for everyday life practices and should be second nature to students upon graduation from high school.

Photosynthesis has been neglected due to “testing” practices. The prior state standards asked one question concerning the photosynthetic process; therefor, priority was given to other topics where more attention was being focused on by the state. However, photosynthesis is the core upon which our lives depend – it is the beginning of life’s energy pyramid. How can it be justified to ignore this fundamental biological concept? It cannot be justified and is the basis for the following activities.

Table of Contents

Module 1: Photosynthesis and Respiration

1. Indications of Photosynthesis
2. What’s Up with Air
3. Carbon Cycle worksheet
4. Reasoning Matter and Energy: Analysis of Two Experiments
5. Experiment with Lentil Seeds

Module 2: Carbon Cycle

1. Temperature Variation in Gases
2. Heat Capacity of Water versus Sand
3. Sea Ice versus Glaciers
4. Ocean Acidification: Demo and Article Analysis
5. Graphing the Keeling Curve

Module 3: Greenhouse Effect and Assessment

1. Article Analysis: Carbon Neutral Olympics
2. Energy Audit Activity

Next Generation Science Standards (NGSS) – High School

LS1.C; LS2.B; Ls2.2; LS2.5; LS4.6: Organization for Matter and Energy Flow in Organisms

Life Sciences: The process of photosynthesis converting light energy to chemical energy by converting carbon dioxide plus water into sugars and releases oxygen \* Photosynthesis and respiration are important factors in the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes \* Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales \* Anthropogenic changes in the environment, climate change, can disrupt an ecosystem and threaten the survival of species \* Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

ESS3: Earth and Human Activity

Earth and Space Science: The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources \* Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation \* Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts.

PS3D: Energy in Chemical Processes and Everyday Life

Physical Science: The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis \* Solar cells are human-made devices that likewise capture the sun’s energy and produce electrical energy.

ETS1: Engineering Design

Engineering, technology, and the Application of Science: Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities \* Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others.