Topic 4: Energetics – 4g. Photosynthesis: Water Weed Simulation

Resources:

Miller, K., Levine, J. (2004). *Biology.* Boston, MA: Pearson Prentice Hall.

AssessNet. Cambridge Assessment Network [Internet]. University of Cambridge, UK. 23 Oct. 2007. Available from: www.assessnet.org.uk

Max-Planck-Gesellschaft. New Research Sheds Light on Photosynthesis [Internet]. *ScienceDaily*, Science News. 28 Nov. 2006. Available from: http://www.sciencedaily.com/releases/2006/11/061128093235.htm

Building on:

Photosynthesis is a complex issue involving many *variables*. Students need to learn about the *light reactions*, both *cyclic* and *noncyclic* and they need to learn about the *Calvin-Benson cycle*. Putting all of the information together to explain how *light energy* is converted to *chemical energy* so that it can be stored for future use can be overwhelming. Students know that light is necessary for photosynthesis, but they may not have thought about how changes in the color or the intensity of the light might change *photosynthetic efficiency*.

Students should also know the *chemical equation* for photosynthesis and recognize carbon dioxide and water as *reactants* and oxygen and glucose as *products.* If the amount of one of the *reactants is limited,* how will that affect photosynthesis?

This simulation allows students to manipulate the variables of *light color, light intensity,* and *carbon dioxide concentration* to measure the affect each has on photosynthesis.

Links to Chemistry:

Chemical equations
Stoichiometry
Limiting reactants
Oxidation and reduction
Chemical bonds
Bond formation

Links to Physics:

Conservation of energy
Efficiency
Conservation of matter
Free energy
Absorption of radiant energy
Light and wavelength
Color
Refraction of light

Stories:

The light reaction of photosynthesis splits water, releasing oxygen, NADPH, and ATP. The NADPH and the ATP along with carbon dioxide are needed by the Calvin-Benson cycle to make glucose. The water is actually split by photosystem II on the thylakoid of the chloroplast. No one completely understands how this reaction takes place, but scientists are very eager to learn. A team working at the Max-Planck Institute has finally figured out the complete structure of the cluster of molecules making up photosystem II. They think that will help them figure out how the photosystem works. This is important because if we could build and control an artificial photosystem II we could generate an endless supply of hydrogen that when combusted would produce water. The water could be split back into hydrogen and oxygen and an endless cycle of carbon-free energy would be available through this artificial photosynthesis.

For more information and links to other research in this area you can go to this website:

http://www.sciencedaily.com/releases/2006/11/061128093235.htm

Instructions for the Website:

This is a website sponsored by Cambridge University in England. You will need to go to the URL: www.assessnet.org.uk

You must register (it is free) and you will receive a login and a password. You will also need to be sure that you have Adobe Shockwave Player on your computer and the computers at your school. Shockwave can also be downloaded for free. Follow the instructions on the lab to try it for yourself. All of your students can use your login and password. The lab is easy to do and can be completed easily in one class period. I did have students that tried to complete it at home and had some trouble. I think it was because they didn't have Shockwave on their home computers.

You will also see that there is a simple rabbit genetics simulation available along with a couple of chemistry and physics simulations.

Biology
Photosynthesis: Water Weed Lab

Introduction: In this simulation, you will be looking at the production of oxygen as a plant (water weed) photosynthesizes. Oxygen is measured in the number of bubbles produced by the plant. Three factors that influence photosynthesis can be adjusted in the simulator to determine how each of the factors affects the rate of photosynthesis.

Hypothesis: How do you think increasing the amount of CO_2 will affect the rate of photosynthesis? Will the rate increase or decrease and why?

Internet:

1. Open Safari web browser on your computer.
2. Enter the web address: www.assessnet.org.uk
3. Click on e-learning.
4. Username: _____
5. Login: _____
6. Click "view all events and courses."
7. Scroll to the bottom and select "Science Simulations."
8. Scroll to the bottom and select "Biology: Water Weed." It will take about a minute to load.

Procedure:

1. The simulation begins with the standard settings:
   a. Light color: colorless
   b. Light level: 2.0
   c. CO_2 level: 2.0
2. Put the speed on the X5 button.
3. Hit start and record the count (bubbles of O_2) at standard conditions.
4. Leaving the light level and the CO_2 at standard conditions, change the color of the light and record the count after each trial. Make an evidence table to organize your data.
5. Now return the color of the light to standard conditions and change the light level, recording the count on an evidence table after each trial. (You must run at least four trials of differing light levels.)
6. Now return light level to the standard conditions and change the CO_2 levels recording the count after each trial on your evidence table. (You must run at least four trials.)
7. Adjust light color, level, and CO_2 level to achieve maximum count. Record those conditions.

Analysis Questions:

1. How did red light vary from blue light in photosynthesis?

2. How did light intensity affect photosynthesis?

3. Which made a greater difference in photosynthesis: light level at its maximum or CO_2 levels at the maximum with all other factors at standard conditions?

4. Why would CO_2 be important to photosynthesis?

5. Where is the oxygen in photosynthesis coming from?

6. Write out the full equation for photosynthesis.

7. What are the reactants for photosynthesis?

8. What settings for the three factors (light level, light color, and CO_2 level) caused the maximum amount of photosynthesis?

Conclusion:

NLQ: