The Sun's Energy and Life on Earth

You have learned that Earth is the third planet from the sun with just the perfect climate to support life, but where does energy for life come from? In this lesson you will learn about how the sun also provides the energy needed by most living things on our planet. You will study the processes of photosynthesis and respiration and how energy is moved through food webs.

Grade levels: Grades 4 – 8

Guiding Question(s):
What gases do plants and animals exchange in order to obtain energy?

Learning Objectives:
Students will know:

What gases are exchanged between plants and animals in an enclosed environment.

Sunshine State Standards:
The student will:

- know that some source of energy is needed for organisms to stay alive and grow. SC.B.2.2.1
- know that green plants use carbon dioxide, water, and sunlight energy to turn minerals and nutrients into the food for growth, maintenance, and reproduction. SC.G.1.2.3

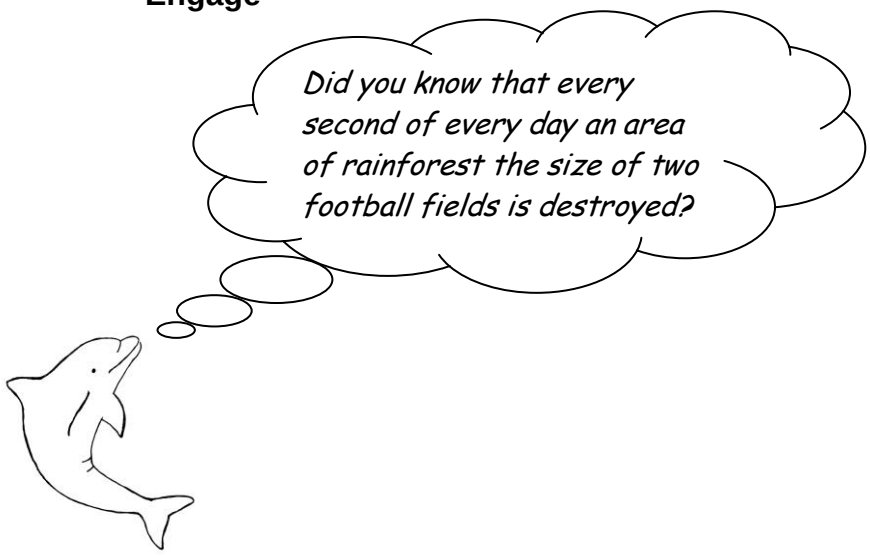
Vocabulary

algae
chlorophyll
consumers
decomposers
ecosystem
food chain
food web
photosynthesis
phytoplankton
predators
primary consumers
producers
rainforest
respiration
secondary consumers
sugar (glucose)

Materials

Activity 1 (per team)
small plastic bag
distilled water
medicine dropper
bromothymol blue solution
snail
plant
Activity 2
Internet or library

Engage



In various parts of the world, **rainforests** are being destroyed to clear the land for farming and cattle ranching. In this activity, you will study what gases are exchanged between plants and animals and how the disappearance of rainforests affects Earth's atmosphere.

Think about this: A little seed weighs next to nothing, but a tree weighs a lot. From where does the tree get the stuff that makes up a wooden desk?

To assess students' prior knowledge, you may also ask students:

They think that plants get their energy from the soil and nutrients. Students often think that plants do not respire.

Common Misconceptions
http://homepage.mac.com/vtalsma/syllabi/2943/handouts/misconcept.html

A Video on Common Misconceptions:
http://www.ted.com/talks/lang/eng/jonathan_drori_on_what_we_think_we_know.html

You may also view "Lessons from Thin Air" at http://www.learner.org/resources/series26.html

Exploration 1:
Photosynthesis and Respiration

In this activity, you will learn about the processes of photosynthesis and respiration. You will use a plant and animal to explore the gases exchanged between plants and animals.

Problem
What gases are exchanged between a plant and an animal in a closed environment?

Select a hypothesis

Bromothymol blue solution will turn yellow if carbon dioxide is present. Based on what you know about photosynthesis and respiration, choose the hypothesis that describes what you think will happen to the color of the water after leaving a snail in water for a 30-minute period.

____ The color of the water will not change color in the bag with the snail.
____ The color of the water will turn yellow in the bag with the snail.

Explain why you chose this hypothesis.

Methods

Collect the materials (per team):

small plastic bag	medicine dropper	plant
bromothymol blue solution	distilled water	snail

Follow the procedures

1. Fill one plastic bag with one-third distilled water.
2. Put 10-15 drops of bromothymol blue solution into the water to make the water a bluish color.
3. Place a snail into the water. Seal the bag and put it in a place where it will remain undisturbed for approximately 30 minutes.
4. After 30 minutes, observe the color of the water in the bag. Record the color of the water in the table on the next page.
5. Unseal the bag and add a plant to the water. Reseal the bag and put it in a place where it will remain undisturbed for 30 minutes
6. Make a second hypothesis.

What do you think will happen to the color of the water in each bag after 30 minutes with both the snail and plant? State your hypothesis. Explain your reasoning.

7. After 30 minutes, observe the snail and plant and record the color of the water in the table below.

Teacher Note:
Students may need to leave the bags set up for a few hours or overnight to see the color change occur. Time for the water to change color varies depending on the activity of the snail and plant.

Extension:
Have one or two teams place a bag with a snail and plant in a place where it will receive no light (in a dark place) for approximately 30 minutes. The color of the water in the bag for the snail and plant left in the dark would remain yellow, because the plant cannot photosynthesize in darkness.

Results

Organisms in Environment	Color of water after 30 minutes	Is carbon dioxide present?	What processes are going on?
Snail			
Snail and plant			

Conclusion

Support of Hypothesis
Compare your hypotheses with what you learned from your research. Did the results match your hypotheses?

_____ Yes _____ No

What evidence did you find to support your conclusion?

_____

Explanation of Findings
Explain your observations.

Explanation

Photosynthesis and respiration are the two main biological processes that cycle carbon through ecosystems.

Algae and most land plants contain a form of the green pigment, **chlorophyll**, which is a light-absorbing molecule that enables algae and plants to convert sunlight into chemical energy. This process is called **photosynthesis**. The word photosynthesis comes from Greek words that mean "putting together by light." During photosynthesis, algae and plants use sunlight to convert carbon dioxide and water into "food" or **sugar (glucose)** and oxygen. This happens as light energy absorbed by the chlorophyll is used to split water molecules. Oxygen is released out of the cells into the atmosphere and the carbon dioxide and remaining hydrogen combine to form the glucose. Glucose is the fuel or energy source needed by living organisms for growth, maintenance, and reproduction.

Photosynthesis is shown in the equation:

$$\text{carbon dioxide} + \text{water} \xrightarrow[\text{sunlight}]{\text{chlorophyll}} \text{sugar (glucose)} + \text{oxygen}$$

Animal cells do not contain chlorophyll and therefore cannot photosynthesize. Animals must eat plants or other animals, whose tissues they break down into the glucose and other materials they need for energy and growth. The process by which living organisms (both plants and animals) convert the glucose into energy is called **respiration**. Oxygen is needed for respiration and this is the reason we need to respire or breathe oxygen.

Respiration is shown in the equation:

$$\text{sugar (glucose)} + \text{oxygen} \longrightarrow \text{carbon dioxide} + \text{water} + \text{energy}$$

A common misconception is that plants only photosynthesize and do not respire. However, plants also must carry out respiration in order to obtain the energy needed to survive and grow.

Evaluation

1. When an animal respires, what gas is released or given off?

carbon dioxide

2. Why did the water change color with the snail?

When an animal respires, carbon dioxide is released. Bromthymol blue solution will turn yellow if carbon dioxide is present.

When the plant is placed in the water with the snail, the color of the water will turn pale blue as carbon dioxide is used up by the plant for photosynthesis.

4. Many trees in the rainforest are being destroyed for farming and ranching. Based on what you have learned in this investigation, explain how the disappearance of the rainforest could affect the type and amount of gases in the environment.

The destruction of the rainforest could cause less carbon dioxide to be used up, leaving more in the atmosphere. There would also be fewer trees to produce oxygen. Even if other plants such as grasses replace the trees, the amount of biomass on a plot of ground is far less than before resulting in less carbon dioxide being consumed. Burning the forest also releases carbon dioxide into the atmosphere.

5. Phytoplankton are photosynthetic algae in the oceans. What gas do these organisms use? What gas do these organisms produce?

Phytoplankton use carbon dioxide for photosynthesis and produce oxygen. Scientists estimate that phytoplankton are responsible for as much as 80% of the oxygen in Earth's atmosphere.

Elaboration

Using the websites below, investigate the carbon cycle. Make a diagram and include the the processes of photosynthesis and respiration.

Websites

The Carbon Cycle
http://www.seed.slb.com/subcontent.aspx?id=3788

Nature Conservancy's Carbon Calculator
http://www.nature.org/initiatives/climatechange/calculator/
Global Footprint Network
http://www.footprintnetwork.org/en/index.php/GFN/

Carbon cycle game
http://www.windows.ucar.edu/earth/climate/carbon_cycle.html

Interactive carbon cycle diagram
http://www.seed.slb.com/en/scictr/watch/climate_change/carbon.htm

Trade Books

Living Sunlight: How Plants Bring The Earth To Life by Penny Chisholm
Photosynthesis: Changing Sunlight into Food by Bobbie Kalman

Careers

Climate Change Scientist
Botanist
Horticulturist