Sun, Light and Life

Teacher Background

No sun, no sunflowers. No plants, no abundant oxygen. No oxygen, no humans. Plants rely on sunlight to power the process of photosynthesis which produces the food on which they rely. All other living organisms on Earth, in turn, either consume plants directly, or live on creatures who do. We're all eaters of sunlight. So while LIVE FROM THE SUN emphasizes that fusion, magnetism, convection and radiation are key processes that we need to understand in connection with the Sun, we'd be derelict to not also offer Activities that demonstrate the Sun's fundamental role in life science. Plants produce the oxygen upon which we humans rely as a by-product of manufacturing the food which they need. Oxygen, our breath of life, is a plant's waste product.

During photosynthesis, the chlorophyll in plant cells uses light energy and raw materials from the soil and air to produce food. Chemical reactions transform carbon dioxide, water (H_2O) and light energy into sugar and oxygen. Some of the oxygen (resulting from the dissolution of the H_2O) is used by plant cells in the process of respiration. The rest of the oxygen is released by the plant through the stomata in its leaves. About 90 percent of the oxygen in our atmosphere comes from photosynthesis. Light energy is also used to combine hydrogen (again resulting from the dissolution of the H_2O) and carbon dioxide to form sugar. Plants use sugar as a source of energy to carry on their life processes, such as growth and reproduction. Sugar can also be stored in the roots or stems of the plant. You're eating this stored "plant food" when you eat carrots and potatoes.

All living things, including plants, carry out the process of respiration. During respiration organisms break down food to release energy. In plants, the chemical reaction of oxygen and glucose produces carbon dioxide, water and energy. After glucose molecules have been broken down into simpler substances, they enter the mitochondria of the cell and combine with oxygen to form water and carbon dioxide. Energy is released during these chemical reactions. This energy is used by the cell to carry out its job. The more energy a cell needs, the more mitochondria it has.

Objectives

Students will relate the presence and absence of light to the rate and characteristics of plant growth (e.g. size and color of leaves.)
Students will demonstrate that plants grow towards sunlight (positive phototropism.)

Vocabulary

photosynthesis, phototropism, respiration

Materials

for teacher demonstration: potted geranium, bean plants, or other easily obtainable plant
cardboard
per student team:
2 bean plants of equal size
2 sneaker boxes

Note: If you plan to do these light activities with multiple classes, it might make sense to germinate and grow several bean plants, and let them reach 3-4 inches in height.

Engage

Do plants need light to stay alive? Do they need light to photosynthesize? Even if the atoms of carbon, hydrogen and oxygen are available, extra glue is still needed to hold the molecule together. The bonding energy in the raw materials is not enough to make huge carbohydrate molecules. Sunlight provides the extra glue. Photosynthesis only happens when a green cell is in sunlight. Without sunlight, no food is made. Without food, plants wither and die. To maximize their leaves' exposure to sunlight, plants grow towards the Sun.

Explain/Explore

Have students/teams work with a potted geranium plant or select a small shrub outside (even a patch of grass will do). Make geometric shapes of an appropriate size from cardboard and attach matching patterns to the upper and lower surface of leaves, resulting in a sandwich which shuts out sunlight. Still simpler, place any opaque object on a patch of grass. Remove the coverings after a week or so. What do you notice? What happened to the color of the leaves? (Without light, leaf bleaching occurs, less chlorophyll is produced, and the leaves are less able to make the food they need. Without food, living things die.)

Take two bean plants of similar size: place one on a windowsill, and the other in a dark closet. Water them equally. Observe them over several days, and record their heights: graph them over time. Apart from their heights, what else changes? Look for differences in color, or size of leaf. Even look for differences in when the soil in the two pots needs more water, and discuss relevance.

Expand/Adapt/Connect

Positive Phototropism

For individual students or student teams: use two bean plants of identical height, both relatively vertical in growth. Construct two covers from sneaker boxes, by removing a square window of approximately 2 inches from one end of each box. Be sure to keep the windows in both boxes as identical as possible. Cover the plants with the boxes, being sure to allow a couple of inches for upward growth, blocking out all the light with the exception of that coming through the 2" window. Place both plants on the same windowsill, where they will receive approximately the same amount of sunlight, but orient one hole left, and one right. Have students predict what they think will happen, and plot results over time. (In a few weeks, one bean plant should be growing noticeably left, and one noticeably right.)

Explain

Chemicals (hormones) in the plant cause cells on the shaded side to grow longer than on the lit side. This results in "positive phototropism" (*phototropism* means light-seeking behavior.) In the rainforest, when a tree-fall suddenly creates new open areas, plants race for the light. But not all plants seek light all the time: some desert plants actually grow away from the sun to keep from over-heating.