A Beginning Look at Photosynthesis: Plants Need Light

Purpose

To develop an understanding of plants' response to light

Overview

Students will do simple investigations to observe plant responses to light.

Student Outcomes

Students demonstrate their understanding that the same plant species may show observable differences under different light conditions (i.e. kinds of light or duration of exposure). Students demonstrate their ability to set up and conduct a simple investigation, and to use process skills.

Science Concepts

Life Sciences

- Organisms' functions relate to their environment.
- Plants and animals have life cycles.
- All organisms must be able to obtain and use resources while living in a constantly changing environment.

Scientific Inquiry Abilities

- Observing
- Inferring
- Predicting
- Collecting data
- Analyzing data
- Setting up and carrying out a simple investigation
- Design and develop scientific investigations.
- Use appropriate tools and techniques.
- Develop explanations and predictions using evidence.
- Use appropriate mathematics to analyze data.

Time

Two full class periods and a number of short sessions over the next two to three weeks to check branches and record observations

Level

Primary and Middle

Materials and Tools

- Small brown paper bags
- Brown paper bags
- Colored cellophane
- Various plants with leaves (inside and/or outside)
- Various light sources (incandescent, cool and warm fluorescent, full spectrum, sun, etc.)
- Rulers
- GLOBE Science Log with two columns, one for narrative description and one for pictorial/graphic

Preparation

Collect a variety of plants. Plants need to be large enough for students to cover three branches of one plant or you will need three replicate plants of each type/species.

Prerequisites

None

Background

Photosynthesis is the process by which plants, algae and some bacteria use light energy to produce food (sugars) out of carbon dioxide and water. *Chlorophyll*, a pigment which gives plants their green color, traps light energy for these organisms to use in making food. Photosynthetic organisms are *producers* that provide food to nearly all *consumers* on Earth. For most living organisms, photosynthesis is the first step in the food chain which connects living things. Every land animal depends to some degree on green plants. Photosynthesizing plants take carbon dioxide from the air, water from the soil, and use energy from the sun. Some of the light energy as it interacts with chlorophyll, is used to split water molecules into hydrogen and oxygen. Light energy is then used to join hydrogen and carbon dioxide together to form a new molecule: sugar. The sugar formed is glucose, the food a plant uses for growth and maintenance. The process of photosynthesis is illustrated in the equation at the bottom of the page.

Sugars that plants make out of carbon dioxide and water are their only source of food that can be used immediately for energy, to make cell materials, or stored for later use. Water and minerals such as nitrogen and phosphorus dissolved in it (which may come from soil) are not sources of energy for plants or animals; therefore these are not considered plant food even though they are required for growth and survival.

What to Do and How to Do It

Getting Ready

1. Ask and discuss the following questions:
   - What do you think would happen if I put my favorite classroom plant in the closet for the rest of the year? Why do you think that might be?
   - What do you think plants need to live?
   - Have you heard the word photosynthesis?
   - What do you know about it? (Do not go into detail at this point, however.)
   - Do you think plants can grow with any kind of light?
   - Ask students what they think would happen if trees outside were covered and had no light. Ask what could cause this (lack of light and trees being covered) to happen.
   - Why do you think plant survival is important? (Be sure students understand that because of the food chain, all animals rely on plants for survival.)
2. Tell students they are going to set up a test to see what happens when part of a plant or a whole plant does not get light.

Exploration

Note: Beginning students will most likely need to do this as a group. Intermediate students can work independently in small groups using the following Work Sheet.

1. If appropriate for your students, discuss what *variables* (things that can change the result of the investigation) need to be controlled (or kept constant) to make this investigation

$$6\,CO_2 \text{ (carbon dioxide)} + 6\,H_2O \text{ (water)} + \text{light energy} \xrightarrow[\text{chlorophyll}]{} C_6H_{12}O_6 \text{ (glucose)} + 6\,O_2 \text{ (oxygen)}$$

a *fair test* of the need for light without having other factors come into play. Help students to understand that, as much as possible, everything needs to be kept the same except for the one thing that they will be changing, the kind or the duration of light.

2. Have each group decide what aspect of light they want to test (kind of light source, duration of exposure to light, distance from light source, etc.). Have each group give a prediction of what they think might happen depending on the variable they chose to test.
3. Have groups set up their investigation. Be sure to allow for replication by having students use more than one plant of the same species or more than one plant part per variable being tested. If necessary, discuss with each group how they are controlling all variables except the selected one. For example, if they chose to test the type or kind of light source, is the distance of the light source and the duration of exposure time the same for all the plants?
4. Have each group of students select three plants of the same species or three branches on one plant for the variable they are testing, and another set of three plants/branches for the control or, if possible, set up a *control* for the entire class. Students may use whole plants or plant parts, depending on the size and availability.
5. Decide as a group how often plants will be checked (observed) and data gathered. For intermediate students, discuss with each group what they think are ways of observing quantitatively or collecting quantitative data (Will they do any measurements, i.e. length or width of leaves, height of plant, count number of healthy looking or sick looking leaves etc.?)
6. Have students check plants carefully on a regular basis and write and draw their observations (what is happening), inferences ("why do you suppose it happened" idea), and predictions ("what is going to happen next" idea), in their science logs. Take a minute regularly to have students share and discuss these observations, inferences, and predictions. Be sure they understand that an observation is detected by one or more of their five senses, whereas an inference is a guess at what might have caused the effect they are observing. This is worth reviewing regularly, so students have a clear picture that observation and inference are two very different skills that are important in science. Prediction is a guess at what might happen given a scenario or set of circumstances. It may help to make three columns on a chart labeled *Observation*, *Inference*, *and Prediction* and put each observation in the correct columns. If students give you an inference when they should have observed, ask for the evidence that led them to their inference. For older students, you may want to require that they do quantitative observations or collect quantitative data. See step 5.

Discussion Questions/Generalize

Ask each group to report the results of the investigation on their plant(s). Discuss conclusions as a group. Ask students why they think they got the results that they did. If they say that plants need light to live or be healthy, ask them why they think that is. For what do they think the plant needs light? For younger students, don't worry about a thorough explanation of photosynthesis at this time if students don't already have a grasp of the concept. It is sufficient that they understand that plants need food, and that plants use sunlight to help make food (in the form of sugar) in a process called *photosynthesis*. For older students, it might be appropriate to discuss photosynthesis at this time (See background) and include information they have read on similar investigations done by other workers.

Assessment

Science Log Entry

Have students write and draw in their GLOBE Science Logs their ideas about:

- Why observation and inference is important in science and how they used these skills in their test or investigation
- Why it is important to cover their three test branches of plants with the same bags, water plants the same, and fertilize them the same
- How plants respond to various light conditions and why

Use the following rubric to score the writing. Primary students who have difficulty writing can be interviewed for understanding.

Skills Checklist

Use the checklist during the lesson to document students' skill abilities.

Performance Task

Have students observe a plant or plant part from your local environment. Tell them to use the most possible number of senses except taste. Students should be able to use four of their five senses (sight, touch, hearing, smell). Record their observations (qualitative and/or quantitative).

Have students infer some reasonable explanations why several leaves on the same plant are different.

Use the following rubric to score the writing. Primary students who have difficulty writing can be interviewed for understanding.

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Skills of Science Assessment Checklist

Criteria	Student Names							
Identifies and controls variables								
Sets up investigation (including replication)								
Observes carefully using four senses, qualitative observations								
Measures accurately, quantitative observations								
Records data (observations of plants)								
Infers reasonable causes for results								

Assessment Rubric

A Beginning Look at Photosynthesis
Journal and Performance Rubric

	5	4	3	2	1
Discussion – Importance of observation and inference	Discussion shows thorough understanding of terms and several good examples of why they are important	Explanation in student's words of several ways observation and inference are important and example of importance	Explanation in student's words of several ways observation and inference are important	Discussion shows understanding of the terms and some ability to discuss their importance	Discussion shows lack of understanding of terms, observation and/ or inference
Discussion– Importance of controlling variables and the need for replication or repeated tests in investigations	Understands variables and the need to control them and need for replication; Well explained generalizations beyond this investigation	Understands variables and the need to control them and need for replication; Some ability to generalize beyond this investigation	Understands variables and the need to control them and need for replication	Understands variables but not the need to control them nor the need for replication	Some details provided but discussion shows lack of understanding of variables and the need to control them
Discussion – How plants might respond to light and why	Discussion shows thorough understanding of how plants respond to light and why; Includes examples other than from investigation	Discussion shows thorough understanding of how plants respond to light and why; Includes example other than from investigation	Discussion shows good ability to generalize investigation results to how plants respond to light and why	Discussion shows some ability to generalize investigation results to plant response to light and possible causes	Little evidence of an understanding of how plants respond to light and why
Performance Task – Uses observation skills to gather data about local environment	States a number of quantitative and qualitative observations using more than three senses; No inferences included	States a number of quantitative and qualitative observations using at least three senses; No inferences included	States a number of quantitative and qualitative observations; No inferences included	States a number of observations but they do not reflect in depth effort; No quantification present; No inferences included	States observations that are few and superficial. No quantification present; No inferences included
Performance Task – Uses inference to propose causes for what he/she has observed	In depth discussion of at three reasonable inferences; Ability to generate reasonable generalization based on inferences beyond local environment	In depth discussion of three reasonable inferences; Supporting sentences	At least three inferences that are reasonable and developmentally appropriate; Inferences may be just one sentence	At least one reasonable inference that is reasonable and developmentally appropriate	Inferences are mostly incorrect