Science Unit: ***Plants***

Lesson 5: ***Plant Growth - Light and Shade***

School year:	2004/2005
Developed for:	Queen Alexandra Elementary School, Vancouver School District
Developed by:	Paige Axelrood (scientist) and Janet Vesterback (teacher)
Grade level:	Presented to grade 3; appropriate for grades 2 – 6 with age appropriate modifications.
Duration of lesson:	1 hr and 20 min
Notes:	Lesson requires extension by teacher for 6 weeks

Objectives

1. Gain experience planting seeds and growing two varieties of plants.
2. Gain experience doing a science experiment that includes making predictions, recording weekly observations of plant growth, and formulating conclusions.
3. Learn what is required for plant growth and healthy plant development.
4. Learn how plant growth is altered if adequate light is not available by comparing plant growth under light and shade incubation.
5. Learn about photosynthesis.

Background Information

To grow to their full potential, plants need an adequate amount of light and water, a favorable temperature, growing medium such as soil or a standard planting mix, space so that the leaves and roots are not crowded, oxygen, and mineral nutrients. Plants make their own food through the process of photosynthesis by using light energy, carbon dioxide, water, and chlorophyll (a green pigment present in leaves). Photosynthesis produces chemical energy for the plant (sugar), and oxygen is released into the air through stomata (small openings present on the underside of leaves).

Plants have adapted to grow under full sun, partial shade or full shade, and therefore plant species vary in their requirements for light. Most plants grow well in temperatures between 18℃ - 26℃ (64.4℉ - 78.8℉), although some plants prefer cooler tempera tures. The amount of water that plants require depends upon the plant species, the size of the plant, the temperature, and the time of year. Plants require many nutrients for growth and development including nitrogen, phosphorous, and potassium. Often soil does not contain adequate amounts of nutrients and these are added to soil as fertilizer. Plant roots absorb nutrients dissolved in water and these nutrients are transported to other parts of the plant.

Vocabulary

Light:	A form of energy, it allows us to see with our eyes; sources of light include the sun, fire, and a light bulb.
Shade:	A decrease in the amount of light caused by a semi-transparent or opaque object that blocks the light.
Water:	A colorless liquid that you can see through; a molecule of water is comprised of two atoms of hydrogen and one atom of oxygen (H_2O); water occurs on earth as rain,

	oceans, lakes, rivers, etc.
Photosynthesis:	A biological process that uses light energy from the sun (or an artificial light source), carbon dioxide from the air, water, and chlorophyll to produce food (sugar) and oxygen; photosynthesis occurs in plants, algae (single celled plant with no true root, stem or leaf), and photosynthetic bacteria.
Replication:	To repeat; do again.
Prediction:	A statement of what you think will happen.
Variation or Variability:	Differences among individuals of the same type; a thing that is somewhat different than another thing of the same kind.

Materials

- Lentil and pea seeds (purchased from a bulk food store)
- 2 plastic containers to soak seeds in water
- Paper towels
- Clear plastic cups with a drainage hole or standard plastic planting containers (2 containers per student)
- Strainer to rinse seeds
- Standard planting mix
- Rulers
- 4 wooden chopsticks (to press into the planting mix to make planting holes)
- 4 containers (to measure the amount of soil required for each container)
- 4 small measuring cups with millimeter markings (to measure water)
- 4 permanent marking pens
- Container for pouring water into small measuring cups
- A light stand with 4 or more plant growth lights (4 foot length lights)
- A support structure to create a shade environment with cloth walls

In the Classroom

Introductory Discussion

1. Ask students why plants are important and what a plant needs to grow. Discuss what is required for healthy plant development. Ask why plants need sunlight and water to stay alive. Then discuss the process of photosynthesis.
2. Discuss the plant growth experiment: to determine if plant growth is altered by shade incubation in comparison to light incubation during a 6 week time period, and to compare the growth of pea and lentil plants under these conditions. Light incubation can be considered the control treatment.
3. Review how to do a science experiment.
    - Make an observation and then ask a question OR start with a question: Will plants grow the same if they are incubated under light and under shade conditions?
    - Think about what will happen to leaves, stems and roots if plants are grown under light and under shade conditions. Write down what you think will happen. This is your prediction.
    - Set up an experiment, treat everything the same except for one thing (what you want to test)--the amount of light that the plants are exposed to (this is a variable).
    - Make observations of leaves, stems and roots.

- Record data and examine results (think about why things happened the way they did).
- Make conclusions and explain results (compare results to predictions to help you think deeper).
- Communicate results and conclusions.

4. Ask students to record predictions about the stem, leaves, and roots (see questions below) before setting up the experiment.
   - Will plants growing in light be taller, shorter or the same height as plants growing in shade?
   - Will plants growing in light have more leaves, less leaves or the same number of leaves as plants growing in shade?
   - Will plants growing in light have larger leaves, smaller leaves or the same size of leaves as plants growing in shade?
   - Will plants growing in light have darker green leaves, lighter green leaves or leaves of the same green as plants growing in shade?
   - Will plants growing in light have more roots, less roots or the same amount of roots as plant growing in shade?
   - Do you have any other predictions about plants growing in light and in shade?

Science Activity/Experiment

Experiment Title: Comparison of plant growth under light and shade incubation.

Purpose of Experiment: To determine the effect of light and shade on the growth of plants.

Experimental Treatments:

Treatment 1	Light incubation (control treatment)
Treatment 2	Shade incubation

[Note: Students can select two other treatments for the experiment instead of light and shade incubation.]

Methods:

5. Plant varieties: lentil and pea. Each student will grow one plant variety and each plant variety will be grown by half of the class.
6. Each student will plant 3 seeds of the same plant variety in each of 2 plant containers (one for light incubation and the other for shade incubation). Groups of 3 or 4 students will work with the teacher or scientist in residence to plant seeds. The plant containers will be labeled with the plant variety, shade or light, and the student's name.
7. Plant containers should have a drainage hole to avoid waterlog conditions in the soil. A transparent plastic cup (6 or 8 oz) can be used as the plant container. This will allow students to observe root growth during the experiment. A hole can be made in the bottom of plastic cups with a heated metal instrument, but this should be done in a fume hood as the plastic vapors from melting plastic are hazardous.
8. Both light and shade incubation should be set up in the same area of the classroom. Four or more plant growth lights (4-foot length) should be placed 15-20 cm above the plants. Connect the lights to a timer and set the timer on a day/night cycle of 16 hours of light/8 hours of dark. Leave the lights on 24 hours per day if a timer is not available. The shade environment can be made with a large cardboard box, cutting out the sides of the box while leaving the corners of the box intact, and draping a lightweight cotton cloth over the sides of the box. Thermometers can be used to monitor the temperatures under light and shade.

9. Soak seeds overnight in water in plastic containers the day before the experiment (one container for each plant variety).
10. Rinse seeds using a strainer and room temperature water, place seeds back into the rinsed empty plastic containers, and cover seeds with a moist paper towel.
11. Measure the planting mix to fill the plant container to approximately 1 cm below the top of the container. Add the same amount of soil to each container.
12. Label the outside of each plant container with the numbers 1, 2, and 3 in three evenly spaced positions near the top of the container. Position the broad end of a chopstick on the inside surface of the plant container next to each number and make a depression (planting hole) in the planting mix approximately 1 cm deep.
13. Gently place a seed in each of the three planting holes and gently cover the seeds with planting mix.
14. Water the surface of the soil so that it becomes uniformly moist. Add the same amount of water to each planting container.
15. Record the date and volume of water given to plants each time they are watered. Plants should be watered when the upper soil surface becomes dry. Have students determine if the same amount of water was given to plants growing under light and shade conditions during the experiment.
16. Record weekly observations of seedling emergence, plant height, the number of leaves and any other observations of the stem, leaves, and roots for the light and shade treatments. Final observations will be made after 5 or 6 weeks incubation.

Closure Discussion

17. Organize all plants grown by students into rows with each row containing the replications of a single plant variety growing under one incubation condition.
18. Ask students to make observations about plant growth and development of the stem, leaves and roots.
19. Review what is required for plants to grow to their full potential.
20. Review what is required for photosynthesis.
21. Discuss what was discovered during the experiment. How did the predictions compare with the experimental results and conclusions?
22. Make observations about the variability in plant growth when comparing different replications of the same plant species growing under the same amount of light. Follow this up with a discussion about why replication is an important component of science experiments.

References

23. http://www.urbanext.uiuc.edu/gpe/index.html University of Illinois Extension, [General information about plants].
24. http://www.urbanext.uiuc.edu/gpe/case1/c1facts3a.html University of Illinois Extension, [Growing plants indoors].
25. http://www.ces.ncsu.edu/cumberland/fertpage/plantnutri.html North Carolina Agricultural and Technical State University Cooperative Extension, [Plant nutrient needs].
26. Hunken, Jorie. 1993. Botany for all Ages, Discovering nature through activities for children and adults. The Globe Pequot Press. Old Saybrook, Connecticut.

Teacher Assessment of Learning

27. How successfully have students been able to make predictions and record observations over an extended period? How detailed and accurate were their drawings and notes?

28. Did students demonstrate an understanding of the concept of variability within the parameters of same plant species and the same conditions of growth? (i.e., the 3 seedlings, although treated the same in either the light or the shade environment, will exhibit some differences. This is a reinforcement of previous learning in the mung bean experiment where not all the beans in any given environment, whether dry, damp or wet, grew at the same rate or in the same way.)

29. Were students able to draw logical conclusions based on their data? Were they able to explain any differences (or similarities) between their predictions and the outcomes of their experimentation?

30. Can students explain verbally the importance of replication when doing science experiments?

Extension of Lesson Plan

31. Plant extra pea plants to study photosynthesis and plant transpiration. Have students make predictions before doing the following activities.

    - Cover some leaves with foil and incubate plants under lights for several days.
    - Compare the color of the leaves that were covered with foil to the leaves that were left uncovered. Discuss the pigment chlorophyll and photosynthesis. Chlorophyll breaks down in the absence of light.

32. Place a plant under a large glass jar or inside a clear plastic bag for 1 day and observe the water droplets that form on the inside of the jar. If a plastic bag is used, support the bag with rulers or chopsticks so that it remains upright and doesn't touch the leaves.

Ask students why the water droplets formed on the inside of the jar or bag. The droplets (condensation) are formed from water vapor that is released by the plant (this is called transpiration). The water vapor is released from openings (stomata) on the underside of plant leaves.

Experiment: Compare Plants Growing in Light and in Shade **Scientist:**_____

Date: _____

PREDICTIONS:

Will plants growing in light be taller, shorter or the same height as plants growing in shade?

Will plants growing in light have more leaves, less leaves or the same number of leaves as plants growing in shade?

Will plants growing in light have larger leaves, smaller leaves or the same size of leaves as plants growing in shade?

Will plants growing in light have darker green leaves, lighter green leaves or the same green leaves as plants growing in shade?

Will plants growing in light have more roots, less roots or the same amount of roots as plant growing in shade?

Do you have any other predictions about plants growing in light and in shade?

Experiment: Compare Plants Growing in Light and in Shade **Scientist:**_____

Date seeds planted:_____ **Plant Variety:**_____

MEASURE PLANT HEIGHT IN CENTIMETERS AND COUNT THE NUMBER OF LEAVES.

	LIGHT			SHADE		
	Plant 1	**Plant 2**	**Plant 3**	**Plant 1**	**Plant 2**	**Plant 3**
Week 1: number of seedings above soil						
Number of leaves						
Week 2: Plant height						
Number of leaves						
Week 3: Plant height						
Number of leaves						
Week 4: Plant height						
Number of leaves						

Experiment: Compare Plants Growing in Light and in Shade **Scientist:**_____

Date seeds planted:_____ **Plant Variety:**_____

MEASURE PLANT HEIGHT IN CENTIMETERS AND COUNT THE NUMBER OF LEAVES.

	LIGHT			SHADE		
	Plant 1	**Plant 2**	**Plant 3**	**Plant 1**	**Plant 2**	**Plant 3**
Week 5: Plant height						
Number of leaves						
Week 6: Plant height						
Number of leaves						

Experiment: Compare Plants Growing in Light and in Shade **Scientist:**_____

Date seeds planted:_____ **Plant Variety:**_____

OBSERVATIONS

Week Number:	**Date:**
Plant Variety:	**Name:**

LIGHT
Observations: Stem, leaves and roots

Stem	
Leaves	
Roots	

SHADE
Observations: Stem, leaves and roots

Stem	
Leaves	
Roots	

Experiment: Compare Plants Growing in Light and in Shade

Scientist: _____

Date seeds planted: _____

Plant Variety: _____

CONCLUSIONS

Date: _____