

## **Photosynthesis**

Grade Level: 5<sup>th</sup> Grade Science: Plant Structures and Processes

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Length of Unit: Five Lessons-Lesson One may be divided into two forty minute classes or taught in a block

### **I. ABSTRACT**

- A. This unit reinforces the process of scientific investigation while introducing the plant structures, processes of vascular plants, and photosynthesis as found in the Core Knowledge Sequence for fifth grade. It utilizes a variety of auditory, visual and kinesthetic activities to explore plant structures and photosynthesis.

### **II. OVERVIEW**

- A. Concept Objectives
1. Understand the process of scientific investigation.
  2. Understand the structure of living systems.
- B. Content from the Core Knowledge Sequence
1. Nonvascular plants
  2. Vascular plants
  3. Photosynthesis is an important life process that occurs in plant cells, but not animal cells
  4. Role in photosynthesis of: energy from sunlight, chlorophyll, carbon dioxide and water, xylem and phloem, stomata, oxygen, sugar (glucose)
- C. Skill Objectives
1. The student will ask questions and state predictions that can be addressed through scientific investigation. [Colorado State Standard 1.1]
  2. The student will explore the process of photosynthesis. [CSS3]
  3. The student will identify plant structures and functions.

### **III. BACKGROUND KNOWLEDGE**

- A. For Teachers
1. Biology For Every Kid, Janice Van Cleave, provided ideas for numerous experiments with very accessible materials to demonstrate both the vascular system and photosynthesis.
  2. Photosynthesis, Alvin Silverstein, provided an in depth yet easy to understand description of the process of photosynthesis. This book is very comprehensible for fifth grade students.
  3. Newton's Apple, "Photosynthesis: how do plants make food?" Provided ideas and further information online.
- B. For Students
1. Students should understand the steps involved in the scientific procedure
  2. Safe lab techniques and procedure
  3. Basic scientific terminology

#### IV. RESOURCES

- A. Malcolm, Penny, How Plants Grow
- B. Silverstein, Alvin, Photosynthesis
- C. Van Cleave, Janice, Biology For Every Kid
- D. *AZ Master Gardener Manual: Plant Parts and Functions* (Online)  
<http://phylogeny.arizona.edu/pubs/garden/mg/botany/plantparts.html>
- E. *Newton's Function* (Online) <http://ericir.syr.edu/Projects/Newton/9/phytosy.html>
- F. Copies of Appendices

#### V. LESSONS

##### **Lesson One: Vascular and Nonvascular Plants**

- A. *Daily Objectives*
  - 1. Lesson Content
    - a. Vascular Plants
    - b. Nonvascular Plants
  - 2. Concept Objective(s)
    - a. Understand the process of scientific investigation.
    - b. Understand the structure of living systems.
  - 3. Skill Objective(s)
    - a. Ask questions and state predictions through scientific investigation.
    - b. Identify the parts and function of a vascular system.
- B. *Materials*
  - 1. Appendices A, B, C, D, and E
  - 2. Overhead of Appendices B and C
  - 3. Appendix A-four copies per student
- C. *Background Notes*
  - 1. Vascular plant systems
    - a. responsible for conduction of water and dissolved nutrients
    - b. examples: celery, carnation, daisy
  - 2. Nonvascular plants
    - a. do not have a conduction system
    - b. dissolved nutrients move directly from cell to cell
    - c. examples: algae, moss
  - 3. Students will make predictions for investigations one and two based on content presented during lesson one. Predictions for investigations three and four will be based on hypothesis without content presented in class up to this point. Predictions may become more detailed as the unit progresses.
- D. *Key Vocabulary*
  - 1. Vascular system: transports water and dissolved nutrients and offers structural support for the plant
  - 2. Vascular plant: has a tube like structure that allows water and dissolved nutrients to move from roots to leaves, and food to move from leaves to the rest of the plant

3. Nonvascular plant: does not have a conduction system; dissolved nutrients move from cell to cell

C. *Procedures/Activities*

1. Introduce vocabulary for lesson—this is a good time to connect the vascular system to the circulatory system which was covered in fourth grade.
2. Ask for examples of vascular and nonvascular plants.
3. Start Investigation One.
  - a. Have students fill in:
    - i. Purpose
    - ii. Materials
    - iii. Procedurefor Investigation One—this information could be put on an overhead transparency (Appendix B).
  - b. Working in pairs, students will complete procedure steps one through six on Investigation One (Appendix B). Students will check off each procedural step as they are completed. (Students will need to review scientific terminology used when recording observations)
  - c. Record day one observation on lab sheet. Daily drawings will also be appropriate (Appendix A).

Note—Students will make daily observations with procedure number eight part of the culminating activity.

4. Proceed with Investigation Two in a similar manner.
5. Students omit purpose but fill out materials and procedure for Investigations Three and Four (Appendices D and E). Students will determine the purpose of this investigation as part of the culminating activity.
6. Proceed with Investigations Three and Four.
7. Discuss the necessity of precise language and also the need to record scientific principles when filling in the daily lab observations

D. *Evaluation/Assessment*

1. Class participation
2. Check initial recording on student lab sheets.

E. *Standardized Test/State Test Connections*

1. The student will ask questions and state predictions through scientific investigation. [CSS 1.1]

**Lesson Two: Parts and Functions of Plants**

A. *Daily Objectives*

1. Lesson Content
  - a. Roots, stems and leaves of vascular plants
2. Concept Objective(s)
  - a. Understand the process of scientific investigation.
  - b. Understand the structure of living systems.
3. Skill Objective
  - a. Observe and record scientific investigations.

- b. Make predictions based on scientific principle.
  - c. Identify basic parts of a vascular plant.
- B. *Materials*
  - 1. Overhead of Appendix F
  - 2. Student handouts of Appendix F
  - 3. Handouts from previous investigations
- C. *Background Notes*
  - 1. Roots: anchor plant and absorb water and minerals, which are moved through the stems and leaves
    - a. do not respond to light
    - b. respond to gravity
    - c. consist of primary and lateral roots as well as root hairs
  - 2. Stems: structures which support buds and leaves
    - a. serve as conduits for carrying water, minerals and sugars
    - b. consist of xylem, phloem and cambium
    - c. cambium-located between the xylem and phloem; the tissue responsible for a stem's increase in girth
  - 3. Leaves: principle function is to absorb sunlight
    - a. sunlight used for manufacturing of plant sugars in photosynthesis
  - 4. Phloem: Conducts dissolved nutrients throughout the plant
- D. *Key Vocabulary*
  - 1. Roots: anchor plant and absorb water and minerals which are moved through the stems and leaves by xylem-some are food storage-carrot, beet radish
  - 2. Stems: support the leaf system-they contain xylem which conduct water and dissolved nutrients to leaves and phloem which conduct food throughout the plant
  - 3. Leaves: primary food making (photosynthesis) organ
- E. *Procedures/Activities*
  - 1. Brainstorm specific words to allow detailed scientific observations, which will be used on lab sheets.
  - 2. Record observations for Investigations One through Four, which were started during the previous lesson. Daily drawings may be incorporated. Remind students not to taste during investigations unless they are instructed to do so.
  - 3. Share observations-make necessary revisions to lab sheets.
  - 4. Using an overhead transparency have students label parts of a vascular plant and note their functions (Appendix F).
- F. *Evaluation/Assessment*
  - 1. Check progress on student lab sheets
  - 2. Collect vascular plant diagram (Appendix F)
- G. *Standardized Test/State Test Connections*
  - 1. The student will ask questions and make predictions that can be addressed through scientific investigation. [CSS 1.1]

### **Lesson Three:       Photosynthesis**

#### **A.     *Daily Objectives***

1.     Lesson Content
  - a.     Leaf structure
  - b.     Process of photosynthesis
2.     Concept Objective(s)
  - a.     Understand the process of scientific investigation.
  - b.     Understand the structure of living systems.
3.     Skill Objective(s)
  - a.     Ask questions and state predictions through scientific investigation.
  - b.     Identify basic leaf structure.

#### **B.     *Materials***

1.     Overhead of Appendix G
2.     Return student handout of Appendix F

#### **C.     *Background Notes***

1.     Photosynthesis is believed to be the most important natural process according to many scientists (photo=light, synthesis+ putting together)
  - a.     provides the fuel from which we receive energy
  - b.     provides oxygen to burn the fuel
  - c.     keeps climactic balance of the earth
  - d.     plants use sunlight energy to combine carbon dioxide from the air and water from the soil to produce sugar
  - e.     oxygen is a by-product of photosynthesis
2.     If photosynthesis is the most important process in nature chlorophyll may be considered the most important biological molecule.
  - a.     is the reason plants are green
  - b.     catalyst in helping chemical reactions take place
  - c.     absorbs and stores sunlight
3.     Leaf structure-Leaves are composed of several layers
  - a.     on top and bottom is the epidermis, a layer of tough, thickened cells with protection of leaf tissue a primary function
  - b.     cells containing chlorophyll absorb energy from the sunlight
  - c.     stoma, openings in epidermis of leaf – stoma are located in the lower epidermis
  - d.     mesophyll is located between the upper and lower epidermis- it is divided into two layers that contain chloroplasts which are the actual sites of the photosynthetic process
4.     Guard cells-guard the interior of the leaf
  - a.     regulate the passage of water, oxygen and carbon dioxide
  - b.     protect stoma
  - c.     are capable of opening and closing depending on the weather conditions
  - d.     close in the absence of light (night)
  - e.     located on bottoms surface of leaf

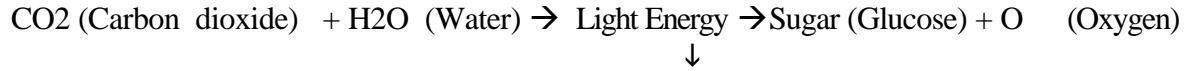
- D. *Key Vocabulary*
1. Photosynthesis: Greek –photo=light, synthesis= putting together-the process where plants use carbon dioxide, water and sunlight to produce their own nutrients
  2. Chlorophyll: green substance which absorbs sunlight and provides energy to produce nutrients
  3. Chloroplasts: cell layer below surface in the leaf which stores chlorophyll
  4. Stoma: tiny pores on the underside of the leaf which absorb carbon dioxide and release oxygen
  5. Stomata: more than one stoma
  6. Guard cells: cells that protect the stoma
- E. *Procedures/Activities*
1. Have students record observations from Investigations One through Four.
  2. Share recorded changes.
  3. Introduce new vocabulary terms and label parts of the leaf cell (Appendix F).
  4. Complete Investigation Five (Appendix G).
  5. As a class discussion, determine whether students are developing new predictions for the outcome of Investigations Three and Four. Why?
  6. Discuss the importance of photosynthesis to the earth, food chains and each student. Would life exist as we know it without photosynthesis?
- F. *Evaluation/Assessment*
1. Collect Leaf Straw lab sheet (Appendix F)
  2. Continue to monitor progress on daily lab observations
- G. *Standardized Test/State Test Connections*
1. The student will ask questions and state predictions that can be addressed through scientific investigation. [CSS 1.1]
  2. The student will explore the process of photosynthesis. [CSS 3]

#### **Lesson Four: More Photosynthesis**

- A. *Daily Objectives*
1. Lesson Content
    - a. Photosynthesis
  2. Concept Objective(s)
    - a. Understand process of scientific investigation.
    - b. Understand structure of living systems.
  3. Skill Objective(s)
    - a. Ask questions and state predictions through scientific observation.
    - b. Illustrate the basic process of photosynthesis.
- B. *Materials*
1. Appendix H
- C. *Background Notes*
1. Photosynthesis is a two-stage process divided into light reactions and dark reactions
    - a. both reactions take place in the light
    - b. the light reaction stops in the dark

- c. in light reactions energy is used to form a chemical compound where the bonds store energy and release it when needed
- d. in dark reactions the chemical is used to build simple sugars and carbon dioxide

2. Photosynthesis equation



↓

Chlorophyll

The process of photosynthesis is a chemical reaction, which can be linked to knowledge from previous units.

D. *Key Vocabulary*

- 1. Review vocabulary from previous lessons.

E. *Procedures/Activities*

- 1. Briefly review vocabulary from previous lessons.
- 2. Record observations for Investigations One through Five on lab sheets. (Remember to encourage sketches to clearly contrast the changes that have occurred.)
- 3. Present the equation for photosynthesis.
- 4. Have students create a rebus depicting the equation for photosynthesis using color in their illustrations (Appendix H).
- 5. If time allows have students use a thesaurus or dictionary to replace vague words used on their lab sheets with words that are more specific. This will be beneficial during the culminating activity.

F. *Evaluation/Assessment*

- 1. Collect student illustrations (Appendix H)
- 2. Best replaced word contest—ask students to volunteer the specific word they discovered to replace one of the vague words.

G. *Standardized Test/State Test Connections*

- 1. The student will ask questions and state prediction that can be addressed through scientific investigation. [CSS 1.1]
- 2. The student will explore the process of photosynthesis. [CSS 3]

**Lesson Five: Culmination Time**

A. *Daily Objectives*

- 1. Lesson Content
  - a. Vascular Systems
  - b. Plant structure
  - c. Photosynthesis
- 2. Concept Objective(s)
  - a. Understand the process of scientific observation.
  - b. Understand the structure of living systems.
- 3. Skill Objective(s)
  - a. Utilize the investigative process to identify structures and processes of vascular plants.

B. *Materials*

- 1. Appendix I

- C. *Background Notes*  
See previous lessons.
- D. *Key Vocabulary*
  - 1. Compile vocabulary from previous lessons.
- E. *Procedures/Activities*
  - 1. Complete observations.
  - 2. Discuss purpose of Investigation Three to determine which side of the plant leaf takes in gasses. Discuss factual knowledge that led to correct answer.
  - 3. Repeat for Investigation Four. Discuss the effect of varying amounts of light on a plan leaf.
  - 4. Hand out assessment (Appendix I). Allow students to use observation sheets to complete assessment.
  - 5. Classroom discussion of what would be eaten if photosynthesis did not exist.
- F. *Evaluation/Assessment*
  - 1. Collect and grade assessments.
- G. *Standardized Test/State Test Connections*
  - 1. The student will ask questions and state predictions that can be addressed through scientific investigation. [CSS1.1]
  - 2. The student will explore the process of photosynthesis. [CSS 3]

## VI. HANDOUTS/WORKSHEETS

- A. See attachments.

## VII. BIBLIOGRAPHY

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APPENDIX A  
Lesson One

Lab Worksheet

Investigation # \_\_\_\_\_

Purpose: \_\_\_\_\_  
\_\_\_\_\_

Materials: \_\_\_\_\_  
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Procedures-Check off as completed:

- \_\_\_\_\_ 1. \_\_\_\_\_  
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- \_\_\_\_\_ 2. \_\_\_\_\_  
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- \_\_\_\_\_ 3. \_\_\_\_\_  
\_\_\_\_\_
- \_\_\_\_\_ 4. \_\_\_\_\_  
\_\_\_\_\_
- \_\_\_\_\_ 5. \_\_\_\_\_  
\_\_\_\_\_
- \_\_\_\_\_ 6. \_\_\_\_\_  
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APPENDIX A–page 2

- 7. \_\_\_\_\_  
\_\_\_\_\_
- 8. \_\_\_\_\_  
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- 9. \_\_\_\_\_  
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- 10. \_\_\_\_\_  
\_\_\_\_\_

Observation Chart

Day One	Day Two	Day Three	Day Four	Day Five

Result: \_\_\_\_\_  
\_\_\_\_\_

## APPENDIX B

### Lesson One

#### Lab Worksheet

Investigation #   1  

Purpose: To investigate the conduction of water and dissolved matter through a vascular system.

#### Materials:

1. white carnation (or daisy) with an 8 inch stem
2. 2 clear plastic glasses
3. red and blue food coloring
4. water
5. measuring cup
6. (an adult will need a knife or exacto blade to cut stem)

#### Procedures-Check off as completed:

1. Adult will trim bottom of flower stem and cut stem in half lengthwise about six inches.
2. Measure ½ cup of water into each cup.
3. Add ten drops of red food coloring to one cup.
4. Add ten drops of blue food coloring to the other cup.
5. Place one end of flower stem in blue cup and the other in the red cup.
6. Predict result of investigation.
7. Record scientifically worded observation of investigation for each day.
8. Compare prediction with observations and record result of investigation.

Observation Chart-APPENDIX B-page 2

Day One	Day Two	Day Three	Day Four	Day Five

Result: \_\_\_\_\_

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## APPENDIX C

### Lesson One

#### Lab Worksheet

Investigation #   2  

Purpose: To demonstrate the conduction of dissolved nutrients through the vascular system of plants.

#### Materials:

1. 2 fresh stalks of celery with leaves (pale inner stalks are best.) Stalks should be about six inches long.
2. 2 clear plastic glasses
3. 4 tablespoons sugar
4. water
5. measuring cup
6. measuring tablespoon
7. stirrer or spoon
8. masking tape
9. pen

#### Procedures-Check off as completed:

1. With a small piece of masking tape, label one glass "WATER" and one glass "SWEET"
2. Measure ½ cup water into each glass
3. Measure four tablespoons sugar into "SWEET" cup. Stir to dissolve sugar.
4. Place one stalk of celery in each glass.
5. Predict result of investigation.
6. Taste a leaf from each stalk.
7. Record observation for each day.
8. Compare prediction with observation and record result.

Observation Chart-APPENDIX C-page 2

Day One	Day Two	Day Three	Day Four	Day Five

Result: \_\_\_\_\_  
\_\_\_\_\_

APPENDIX D  
Lesson One

Lab Worksheet

Investigation # 3

Purpose: \_\_\_\_\_  
\_\_\_\_\_

Materials:

1. potted plant (preferably geranium)
2. petroleum jelly
3. craft stick for spreading petroleum jelly

Procedures-Check off as completed:

- \_\_\_\_\_ 1. Place plant in dark closet or under a box for three days.
- \_\_\_\_\_ 2. Using craft stick, thickly coat the top of one leaf with petroleum jelly.
- \_\_\_\_\_ 3. Then, thickly coat the bottom of one leaf with petroleum jelly.
- \_\_\_\_\_ 4. Place plant in sunny window. (Remember to water as necessary.)
- \_\_\_\_\_ 5. Predict what will happen to the leaves. \_\_\_\_\_  
\_\_\_\_\_
- \_\_\_\_\_ 6. Make daily scientifically worded observations.
- \_\_\_\_\_ 7. Compare top coated leaf with an uncoated leaf.
- \_\_\_\_\_ 8. Compare bottom coated leaf with uncoated leaf.
- \_\_\_\_\_ 9. Record result of Investigation #3.

Observation Chart-APPENDIX D-page 2

Day One	Day Two	Day Three	Day Four	Day Five

Result: \_\_\_\_\_  
\_\_\_\_\_

## APPENDIX E

### Lesson One

#### Lab Worksheet

Investigation # 4

Purpose: \_\_\_\_\_  
\_\_\_\_\_

#### Materials:

1. potted plant, small tree or bush
2. cardboard or aluminum foil
3. scissors
4. paper clip

#### Procedures-Check off as completed:

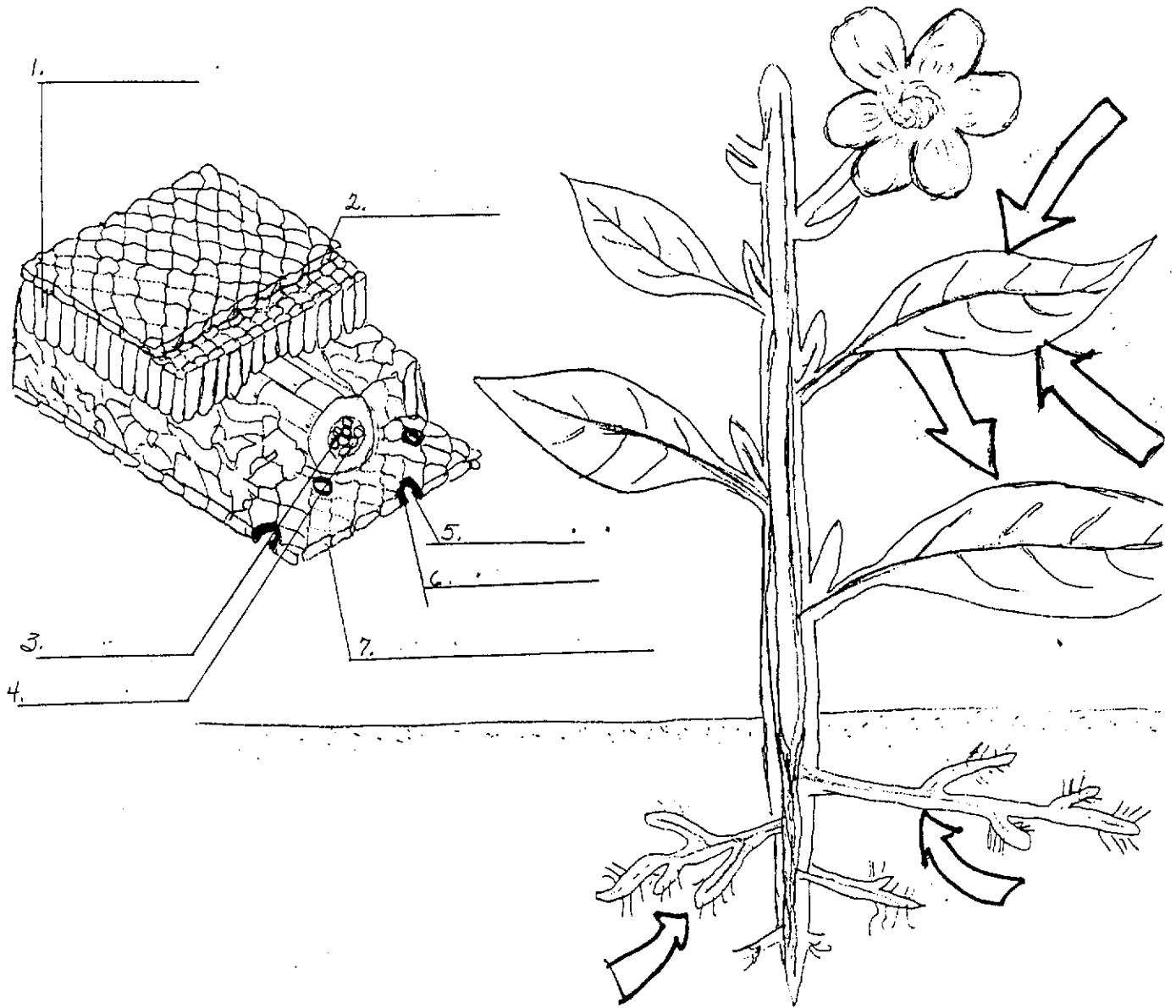
- \_\_\_\_\_ 1. Choose a plant for investigation.
- \_\_\_\_\_ 2. Using cardboard or aluminum foil cut two geometrical shapes. Shapes may be a square, circle, triangle, or a block letter of the alphabet. Shape should be large enough to cover about half of each leaf.
- \_\_\_\_\_ 3. Paper clip each shape to a leaf.
- \_\_\_\_\_ 4. Predict result of Investigation #4.
- \_\_\_\_\_ 5. Place houseplant in sunny window. Observe weather each day and record on observation chart. (Sunny, cloudy, rainy, partly cloudy)
- \_\_\_\_\_ 6. Carefully remove shape on Day 5. Record observation.
- \_\_\_\_\_ 7. Record result of investigation.

Observation Chart-APPENDIX E-page 2

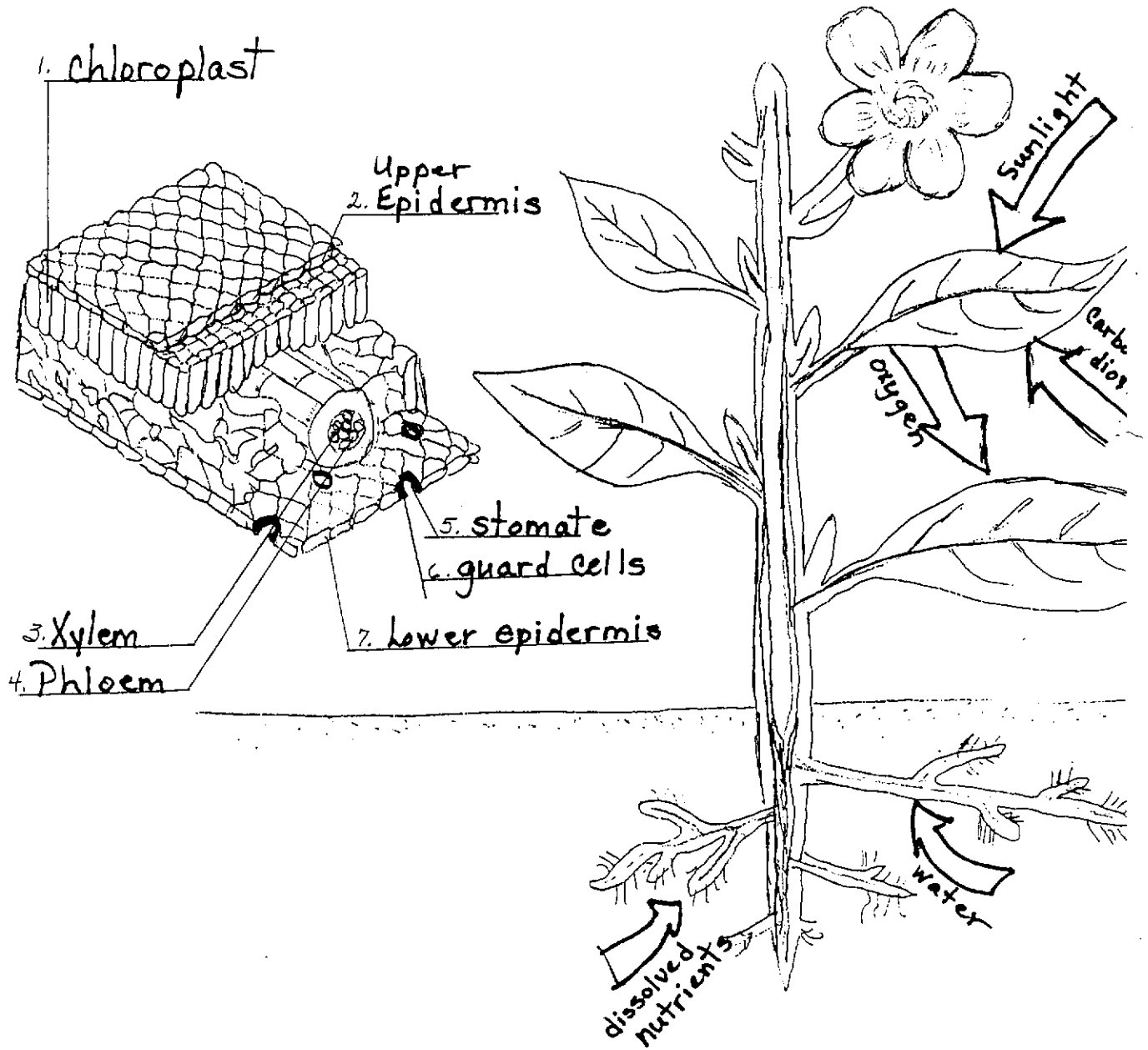
Day One	Day Two	Day Three	Day Four	Day Five

Result: \_\_\_\_\_  
\_\_\_\_\_

Appendix F



Appendix F  
Answer Key



APPENDIX G  
Lesson Three

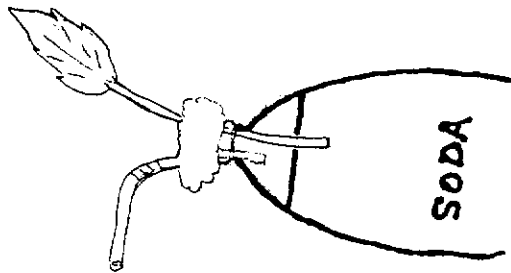
Lab Worksheet

Investigation # 5

Purpose: To demonstrate that the leaves and stems of a plant can act like a straw.

Materials:

- soda bottle, preferably glass
- philodendron leaf with stem
- modeling clay
- flexible drinking straw
- pencil
- mirror
- water



Procedures-Check off as completed:

1. Fill bottle with water to one inch from top.
2. Soften clay and wrap around leaf stem.
3. Place stem in neck of bottle so that the stem is below the surface of the water.
4. Seal clay around mouth of bottle.
5. Carefully use point of pencil to create a hole for the straw.
6. Insert straw so that its opening is in the air space at the top of the bottle.
7. Seal clay around straw so that air can not escape.
8. Predict what will be observed at the base of the leaf stem.

APPENDIX G-page 2

\_\_\_\_9. Watch the mirror while sucking the air from the bottle. This will be very difficult if you have sealed the bottle correctly.

\_\_\_\_10. Compare prediction with observation and record result.

Observation Chart

Day One	Day Two	Day Three	Day Four	Day Five

Result: \_\_\_\_\_  
\_\_\_\_\_

APPENDIX H  
Lesson Four

**PHOTOSYNTHESIS**

Write the equation for the chemical reaction called photosynthesis using symbols.

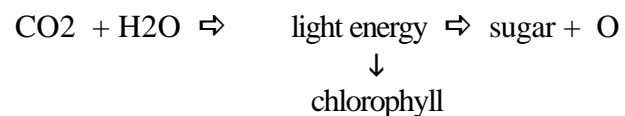
Write the equation for photosynthesis as a sentence.

Draw the equation for photosynthesis using pictures. Color appropriately.

APPENDIX H-Answer Key  
Lesson Four

**PHOTOSYNTHESIS**

Write the equation for the chemical reaction called photosynthesis using symbols.



Write the equation for photosynthesis as a sentence.

Carbon dioxide and water with light energy acting on chlorophyll yields sugar and oxygen.

Draw the equation for photosynthesis using pictures. Color appropriately.

**Use Your Imagination!**

APPENDIX I  
Lesson 5

## Assessment

Directions: Answer the following using the correct names and terms.

1. What did you learn about vascular plants that was demonstrated in Investigation # 1?

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2. What did you learn about vascular plants that was demonstrated in Investigation #2?

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3. What did you learn about the structure and functions of leaves in Investigation #3?

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4. What did you learn about the effect of light on the surface of a leaf in Investigation # 4?

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5. What did you learn about vascular plant structure and function in Investigation # 5?

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APPENDIX I  
Assessment-page 2

6. What did you learn about the chemical reaction that is called photosynthesis? Use specific terms.

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7. What would we eat if the process of photosynthesis did not exist?

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