Unit B: Plant Anatomy

Lesson 3: Understanding Leaf Anatomy and Morphology

Student Learning Objectives: Instruction in this lesson should result in students achieving the following objectives:

1. Describe the main parts of a leaf.
2. Describe some major types of leaves.
3. Discuss common vein patterns found in leaves.
4. Explain how a leaf is organized.
5. Recognize the economical importance of leaves.

Recommended Teaching Time: 2.5 hours

Recommended Resources: The following resources may be useful in teaching this lesson:

- A PowerPoint has also been developed with use of this lesson plan
- http://en.wikipedia.org/wiki/Leaf
- http://www.botany.hawaii.edu/gradstud/sonia/sargassum_echinocarpum/results-leaf%20anatomy.htm
- http://www.enchantedlearning.com/subjects/plants/leaf/

List of Equipment, Tools, Supplies, and Facilities

Writing surface
PowerPoint Projector
PowerPoint slides
Transparency Masters
Copies of Student Lab Sheet
Pressed leaves from a leaf collection
Pictures of leaves from your area
Microscopes
Distilled Water
Clean Microscope Slides
An area to gather leaves from school grounds *or* several live plants provided by the teacher
Several bottles of clear nail polish (approximately 1 bottle for every 6 students)
Plastic baggies (for storing leaves overnight if you don't have time to do the stomata peel the same day)
Dissecting probe
Forceps

Permanent Marker (for labeling the microscope slides)

Terms: The following terms are presented in this lesson (shown in bold italics and on PowerPoint Slide #2):

- Compound leaf
- Cuticle
- Dichotomous venation
- Epidermis
- Guard cells
- Leaf blade
- Midrib
- Netted veins
- Palisade mesophyll
- Parallel veins
- Petiole
- Pinnately netted
- Simple leaf
- Spongy mesophyll
- Stomata

Interest Approach. Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

Have a variety of plants that we eat sitting on a table. These plants will need to be a mixture of plant roots, stems, leaves, fruits, and flowers. Have the students get into equal size groups and as a group guess which of these are leaves. This should be a little bit easier now that they have covered roots and stems.

**** Use this activity to lead into the main parts of a leaf.**

Summary of Content and Teaching Strategies

Objective 1: Describe the main parts of a leaf.

**** This PowerPoint slide allows you to explain the definition and then show the class the leaf part you are talking about. You can do this by clicking on the arrow button next to the definition. This should take you to the picture of the leaf. At this time ask the class to identify the part you are talking about based on the definition you just went over. For example after you go over the tip or apex definition, then click the arrow button (which looks like this: ) next to the definition. When the leaf picture comes up, have the students guess where the apex is located. When you are finished on this part of the leaf, click the arrow next to the apex label. This arrow will appear as this  . This will bring you back to slide #7. You will be able to go through all of the definitions the same way. You may want to experiment with this before actually doing it with the class.**

(PowerPoint Slide #3)

I. Leaves are the primary food producing organs of the plant. They are designed to efficiently collect light and use that light energy to produce food. These are some of the parts of a leaf which help to encourage that efficiency.

(PowerPoint Slide #4)

A. Tip or apex – this is the top of the leaf; It can be pointed, round, smooth, etc
B. Margin – is the edge of the blade; This is quite specific to each species of plant. Some are smooth, toothed, lobed or incised
C. *Midrib* – the central vein running down the center of the blade
D. Veins – contain the xylem & phloem of the plant. They can be parallel or netted in arrangement

(PowerPoint Slide #5)

E. Base – is found at the bottom of the blade; Like the apex, it can be round, heart shaped, flat, etc
F. *Petiole* – is known as the leaf stem; It is not exactly like a stem, but it does hold xylem & phloem; Holds the blade away from the stem
G. *Blade* – the main collecting structure of the leaf; Has a large, broad surface has many layers which help the plant move and store photosynthetic materials and by-products

****TM: B3-1 can be used as a visual aid. PowerPoint #6 also has a picture labeling the parts of the leaf. Have the students repeat the leaf parts together as a class. Instruct them to start at the top of the leaf and work down. Repeat this until all of the students say the leaf parts together.**

Objective 2: Describe some major types of leaves.

(PowerPoint Slide #7)

II. There are many different types of leaves. Some leaves are adapted to hot, dry climates by storing water or being smaller. Some leaves have very large blades to collect the maximum light in a shady location. In some leaves, the blade is broken up into several sections.

(PowerPoint Slide #8)

A. A leaf which has only one blade on its petiole is called a ***simple leaf***. Most plants have simple leaves.
B. In some leaves, the blade is divided into three or more sections. A leaf with multiple blades is called a ***compound leaf***. There are many different kinds of compound leaves.

****Show students examples of compound and simple leaves. This can be done by actually bringing in the plant specimen or by providing pictures from your area. Ask the students to distinguish between the petioles and stems. PowerPoint Slide #9 also has some pictures you can show the class. Also, as you hold up the leaf have the students tell you if it is a compound or simple leaf. If they have trouble doing this, re-explain why it**

is either a simple or compound leaf. Do this until you feel students are comfortable with this objective.

Objective 3: Discuss common vein patterns found in leaves.

(PowerPoint Slide #10)

III. Veins of flowering plants are found in several patterns. Most of these patterns can be categorized into two groups.

A. Monocots have leaves which have ***parallel veins***. While the veins may not be parallel in a strict mathematical sense, none of the veins on the whole leaf will cross each other. It may look like they fuse together at the top or bottom of the blade.

(PowerPoint Slide #11)

B. Dicots have veins which connect and branch from each other. Veins in a branching pattern are called ***netted veins***. Some leaves with netted veins have several smaller veins branching out of a dominant midrib, a condition known as ***pinnately netted***. Other leaves have several dominant veins branching out from the petiole. This condition is known as palmately netted. A few plants have a spreading vein pattern called ***dichotomous venation***. A gingko leaf has this type of veins.

****Ask students to predict whether a plant is a monocot or a dicot based on what pattern of veins they have. After you show them the plant and they give you their prediction, discuss as a class why it is either a monocot or a dicot. PowerPoint Slide #12 also has some pictures that can be used to show the class the vein pattern.**

Objective 4: Explain how a leaf is organized.

(PowerPoint Slide #13)

IV. A leaf is organized to collect sunlight and turn it, through photosynthesis, into food. The leaf blade has many layers of tissue to allow this to happen.

A. On top of the leaf is a waxy non-cellular layer called the ***cuticle***. The cuticle is on the leaf to prevent water from escaping. Generally speaking, plants which live in bright arid conditions have very thick cuticle layers.

(PowerPoint Slide #14)

B. The next layer on the leaf is also there for protection. The ***epidermis*** is the skin-like layer of cells found on both the top and the bottom surface of the leaf. The epidermis may be one or many layers thick.

C. Directly beneath the upper epidermis is a layer of cells which are standing on end and packed very tightly. These standing cells are responsible for most of the photosynthesis in the leaf and are called the ***palisade mesophyll***.

(PowerPoint Slide #15)

D. Under the palisade mesophyll are loosely packed cells called the spongy mesophyll. The ***spongy mesophyll*** forms air spaces which hold raw materials used and products of photosynthesis.

E. The lower epidermis has holes in it for gas exchange. The holes are called ***stomata*** and they can open and close. The opening and closing is controlled by the ***guard cells*****,** which surround each stomata.

****Use TM: B3-2 to help teach the concept. Ask the students to explain purposes for each leaf structure. PowerPoint Slide #16 has a diagram that can also be used.**

****LS: B3-1 will also help reinforce this objective. Divide the students into groups. Ideally you would want two students in a group, but the amount of groups will depend on how many microscopes you have. When each student is finished, discuss the results.**

Objective 5: Recognize the economical importance of leaves

(PowerPoint Slide #17)

V. There are many of species whose leaves have economic uses.

A. The main use of plant leaves by humans is for eating. Freshly picked raw leaves in particular are an excellent source of vitamin and minerals. Leaves that have been picked and stored for awhile or leaves which have been cooked or dried will have smaller amounts of vitamins and minerals, but will still be very beneficial.

(PowerPoint Slide #18)

1. Of all the many foods, green leaves are actually the richest in vitamins and minerals. The reason for this is that these nutrients are also required in photosynthesis
2. We eat leaves of various plants, including artichokes, celery, lettuce, onions, spinach cabbage, Brussels sprouts, oregano, and basil.

(PowerPoint Slide #19)

B. People around the world use herbs not only to flavor their food but for medical purposes.

1. Thyme has been shown to slow down the ageing process by maintaining the vigor of our body cells; sage is an excellent antiseptic for treating mouth ulcers and sore throats; camomile is a safe treatment for children's stomach upsets

(PowerPoint Slide # 20)

C. Leaves of palms and other trees have been used for thatching roofs. Cloth and woven fabrics made from bark, leaves, and other tree parts have also been used for clothing

D. Raked leaves can be used as mulch beneath trees and shrubs.

(PowerPoint Slide # 21)

E. Leaves can also be used to keep certain pests away. For example, in Asia *Elaeagnus umbellata* is planted as an ornamental. However, the leaves can be used to control the cotton aphid, an insect pest. Along with fruits and leaves, roots also have medical uses

Review/Summary: Use the student learning objectives to summarize the lesson. Repeated practice using actual plants, pictures of plants, and drawing plants are very helpful. Student responses can be used to determine which objectives should be reviewed. A few summary questions can be found on **PowerPoint Slides #22 and #23.**

Application: LS: B3-1 can be used to apply objectives to an actual leaf cross-section.

Evaluation: Evaluation should be based on student comprehension of the learning objectives. This can be determined using the attached sample written test.

Answers to Sample Test:

Part One: Matching

1. c
2. a
3. d
4. b

Part Two: Completion

stomata
spongy, palisade
guard
cuticle
parallel, netted

Part Three: Short Answer

1. Compound leaves have more than one blade. Simple leaves have only one blade on each petiole.

Sample Test Name_____

Test

Unit B Lesson 3: Understanding Leaf Anatomy and Morphology

Part One: Matching

Instructions. Match the term with the correct response. Write the letter of the term by the definition.

a. Epidermis
b. Leaf base
c. Midrib
d. Petiole

_____ 1. The single dominant vein in the middle of the blade.

_____ 2. The layer of cells that make up the top and bottom surface of the leaf.

_____ 3. The leaf stem.

_____ 4. The large flat surface of the leaf.

Part Two: Completion

Instructions. Provide the word or words to complete the following statements.

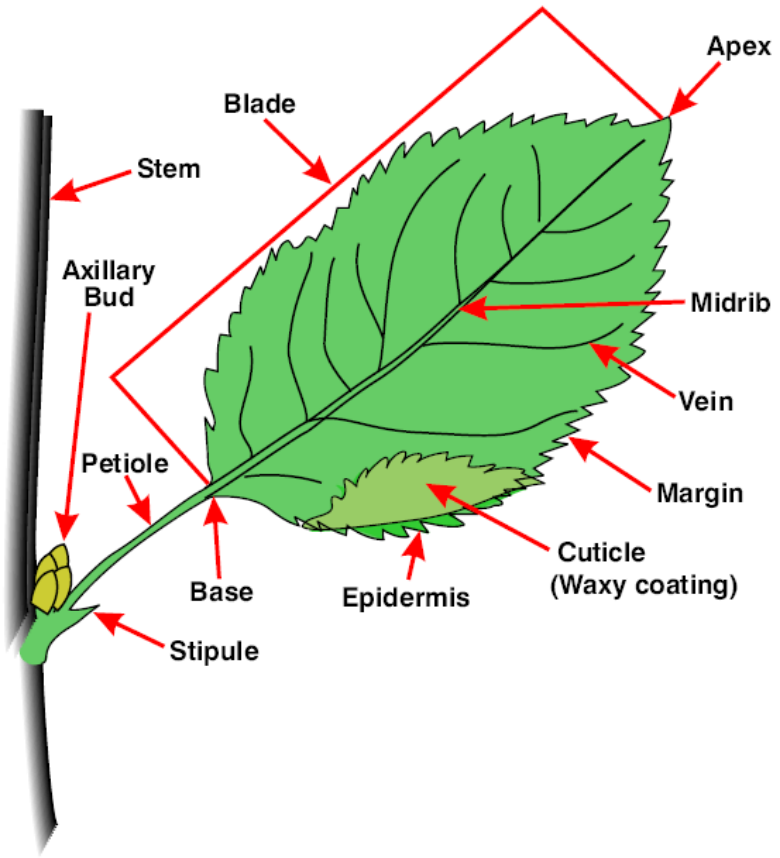
1. The part of the leaf which allows gas to escape is the _____.
2. There are two types of mesophyll. The _____ mesophyll is loosely packed with many air spaces and the _____ mesophyll is tightly packed and stand on end.
3. _____ cells control the opening and closing of the stomata.
4. The waxy upper layer of the leaf is called the _____.
5. Monocots have _____veins while dicots have _____ veins.

Part Three: Short Answer

Instructions. Provide information to answer the following question.

Name the difference between compound and simple leaves.

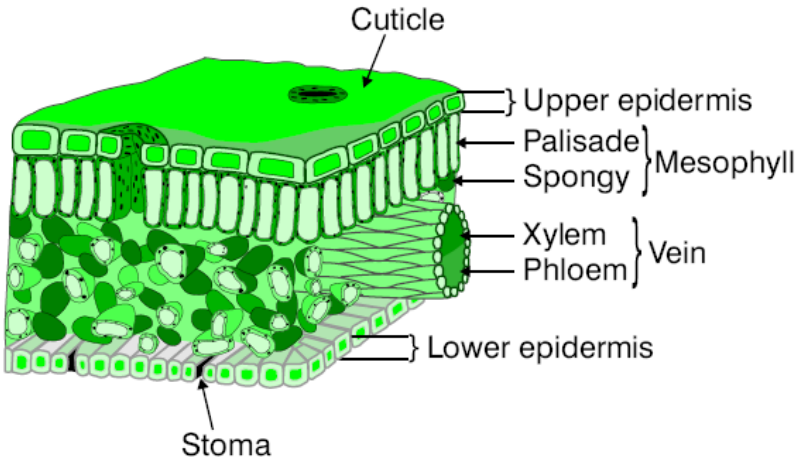
TM: B3-1

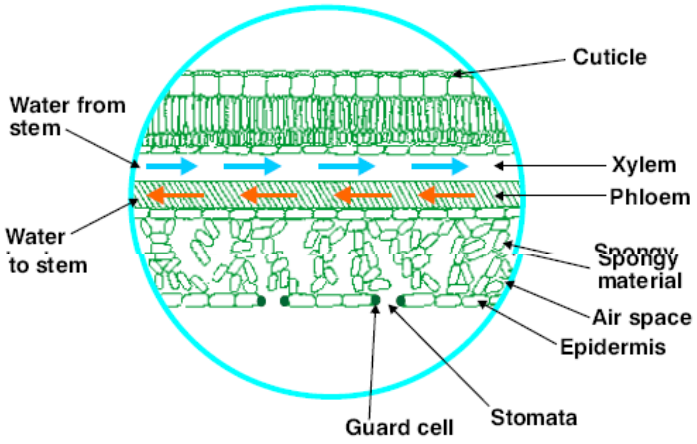


(Courtesy, Interstate Publishers, Inc.)

TM: B3-2

THE CROSS SECTION OF A LEAF BLADE





(Courtesy, Interstate Publishers, Inc.)

LS: B3-1 Name_____

Lab Sheet

Procedure:

1. With your partner, obtain a leaf from a plant found on the school grounds. Try to find a plant that is unique to your class so you can compare your lab results with other members of your class.
2. **In the space provided below, make a drawing of your leaf and make a brief description of leaf size, shape, structure, and where you found it. Include things like venation, where the plant was growing, sun/shade conditions, etc.**
3. Once you have returned to the lab, obtain a bottle of clear nail polish from your instructor.
4. *Each partner* will make a stomata peel of the leaf that you have obtained. One partner will use the top part of the leaf and the other partner will use the bottom part of the leaf. In order to do so, paint a one-centimeter square on each side of your leaf with the nail polish. Make sure that you have covered the entire square with the nail polish. Don't be afraid of putting too much nail polish on, you want to make sure that your peel doesn't rip!
5. Put your leaf aside in a place where it will not be disturbed while it dries (this will take about **10-15 minutes**)
6. When your leaf is completely dry--Using a dissecting probe, GENTLY tease the edge of the nail polish square lifting it away from the leaf surface. Continue to do this along the edge of the square until you have lifted about 5 millimeters of the square away from the leaf. Then, using forceps, remove the rest of the nail polish square from the leaf.
7. Put a drop of distilled water onto a clean microscope slide. Place the stomata peel onto the drop of water **with the side that was touching the leaf facing up**. Using the side of the probe, gently smooth out the peel so that it is flat against the slide. Label your slide with your name, the side of the leaf that the peel is from, the type of leaf (if known), and the year that you made the slide. (Ask your teacher for a marker to do the label.)
8. Observe your stomata peel under the microscope. Focus first under low power, then switch to high power. Answer the questions on the next page in the space provided

Leaf Observation Drawing:

Answer the following questions:

a. **Was this leaf taking in carbon dioxide when you made this peel? How can you tell?**

b. **Was this leaf releasing water when you made this peel? How can you tell?**

c. **Count how many stomata you can see in your field of view. Record how many you can see in your lab notebook. Move the field of view and repeat this step a total of three times then average the number of stomata on your peel.**

d. Compare your average to other student's averages. If the averages are different, what might be the reason? If you wanted to get an accurate stomata count what would be a better number, the average number from one leaf or the average number from many leaves? Why?

e. Record the average number of stomata that your partner observed on their peel.

f. Were there more, less, or about the same number of stomata on the top and bottom side of the leaf? Why do you think this is so? (Think about which side had more and the purpose of the stomata.)

g. Make a drawing of your leaf stomata peel. Label the epidermal cells, the stomata, and the guard cells.