**Sun Shade Leaves - Growth Strategies Lab**

**Purpose**: Review scientific practices, the use of measuring tools and microscopes, data collection, and the proper units to use in science, through an investigation of possible physical differences in leaves found at different locations on the same tree.

**Question**: Do the physical characteristics of leaves differ based on their location on a tree?

**Background**: Photosynthesis is the process in which plants convert nutrients and carbon dioxide absorbed by leaf, using energy from the sun, into sugar that consumers can use. These sugar molecules, when broken apart by oxygen through respiration, provide the energy for the plants! The formula shown below, simplifies this process:

**Carbon Dioxide + Water + Energy (produces)** **Sugar + Oxygen**

 (from the air) (from the roots/air) (from the sun) 

So, plants are converting light energy into chemical energy for use as food, and the oxygen we need to breathe! Photosynthesis occurs in the leaves of a plant. By looking at the equation above we know that leaves must be able to the following:

 1. Collect **sunlight**

 2. Get **carbon dioxide** from the air

 3. Get **water** into the leaf from the roots and from the air

In addition to sunlight, leaves need water and carbon dioxide in order to create simple sugars. Water is taken up by the roots and brought to the leaves in tube-shaped cells (called **xylem**). There are holes, called **stomata**, on the back of the leaf to let in CO2. However, while the stomata are open to let CO2 in, they are also letting H2O out. Leaf structure should reflect a balance between the need for light, CO2 and water, so variations in surface area, thickness and stomata are a result of their environmental conditions. For this activity we will investigate how plants manage the tradeoff between light capture, carbon dioxide collection, and water loss. Depending on the environmental conditions around leaves, their leaf shape or structure may be different to achieve the balance between water, light and carbon dioxide.

**Materials**: pole cutter card stock balance

clippers ruler microscope

plastic bags scissors nail polish, tape, slide

marker

**Pre - Investigation questions:** (Circle Answer “top” or “bottom”)

1. Where on a tree would the most light be available to leaves? (top or bottom)

2. Where on the tree would light be most limited? (top or bottom)

3. Where on a tree would the potential for water loss be greatest? (top or bottom)

4. Where on a tree would the potential for water loss be the lowest? (top or bottom)

*Read the article, Shade and Sun Leaves by G. Hemery and answer the reading questions for homework (separate handout). Consider the* ***tradeoffs*** *between the leaf’s need to gather light and CO2, and the need to conserve H2O and other resources. As a group, come together and review your answers. Work together to answer questions 5-7 below.*

5.a. What would be an advantageous surface area for a leaf to have in an environment where there is little

 light? Why?

 b. Where there is abundant light? Why?

6.a. What would be an advantageous thickness for a leaf to have in an environment where there is the

 potential for a great deal of water loss? Why?

 b. Where there is the potential for very little water loss? Why?

7.a. Where on the tree would it be advantageous for leaves to have many stomata? Why?

 b. To have very few stomata? Why?

**Forming a Hypothesis**

Based on your research and group discussions, develop hypotheses for how leaf size (surface area), thickness, and stomata density would differ between leaves at the top of the tree and leaves at the bottom of the tree. (Remember hypotheses are written in an “if… then…” format, and followed by a justification statement.)

**Leaf Size:**

**Leaf Thickness:**

**# of Stomata:**

**Procedure**:

1. Choose a tree found in your woodland study plot. Gather leaves from lower level branches and from as close to the top as possible; place them in a plastic bag; mark it with the location on the tree and your name.

2. Determine if you have top or bottom leaves and fill in the data tables on Page 4 accordingly.

3. Gather data on both of the leaves.

-Make observations about their characteristics (texture; veins; # lobes; petiole; etc.).

-Mass them; (you need this information to calculate surface area and thickness).

4. Determine the surface area of the leaf. Instead of trying to measure an irregular area, you can use a ratio of the mass of the leaf outline on cardstock to the mass of a known area of card stock.

* 1. Cut out a section of card stock with a known surface area (10cm X 10cm).
	2. Mass it
	3. Carefully trace their outlines on a piece of card stock; carefully cut out the leaf outline
	4. Mass each leaf outline.
	5. Set up a ratio for each leaf – its surface area over its mass = X over the mass of the outline; solve for X.

5. Determine the relative thickness of each leaf by calculating the Specific Leaf Weight (leaf mass / area).

6. Determine the relative number of stomata by making a mold of the **back** of each leaf.

 -On the bottom of each leaf, cover an area about 2cm2 with a thin layer of clear nail polish

 -When it has dried, place a piece of clear tape over the area, press gently, then remove the tape and

 polish.

 -Stick the tape to a clean microscope slide. Label the slide with the leaf location and your initials.

 -View the slide under the microscope; count the number of stomata in the field of view on **high** power.

 -Move the slide and count 2 more times. Calculate the average of your counts.

Tree Species:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**DATA SHEET**

**All data must include correct units!!!!**

**1.** Observations: (list)

2. Leaf masses:

|  |  |  |
| --- | --- | --- |
|  | **Top of tree (g)** | **Bottom of tree (g)** |
| **Mass of leaf**  |   |   |
| **Mass of leaf tracing**  |   |   |

3. Paper square data

|  |  |
| --- | --- |
| **Mass of paper square (g)** |   |
| **Area of paper square (cm2)** |   |

4. Stomata counts

|  |  |  |
| --- | --- | --- |
|  | **Top of tree** | **Bottom of tree** |
| **Stomata 1st FOV**  |   |   |
| **Stomata 2nd FOV**  |   |   |
| **Stomata 3rd FOV**  |   |   |
| **Average** |   |   |

5**.** Leaf Area and thickness

|  |  |  |
| --- | --- | --- |
|  | **Top of tree** | **Bottom of tree** |
| **Leaf Area (cm2)** |   |   |
| **Thickness of leaf**  |   |   |

**Calculations**

**Surface Area (**How big is the leaf?)

Determine the surface area of the leaves using the outline you traced. Since the shape is irregular, we will use a ratio between the mass of a known area (the square) and the mass of the leaf cut out, according to the following formula:

 Area of paper square =  **X** (**X** = area of leaf)

 Mass of paper square Mass of leaf outline

What is the correct unit for area? \_\_\_\_\_\_\_\_ Show your work below and record your answers on the Data Sheet.

Top leaf:

Bottom leaf:

**Thickness of Leaf**

Since we cannot measure the thickness of the leaf, we will calculate it using the Specific Leaf Area (a ratio of leaf area to leaf mass)

Divide your leaf mass by the actual area of the leaf (calculated above). **Use actual leaf mass** **NOT the cut out**. Show your work below and record your answers on your data sheet

 Mass of leaf = Specific Leaf Area (the larger the number, the thicker the leaf)

 Area of Leaf

Top leaf:

Bottom Leaf:

**Results:**

1. Record your data and class data in a table.

Calculate **class averages** once all data has been collected. Record the averages in a table.

2. Create 3 separate graphs comparing the information on the 2 types of leaves. Use the class averages for area, thickness, and stomata density.

**Analysis and Conclusions**:

1. Describe whether the class data supports your hypothesis for:

 a. Leaf Area

|  |
| --- |
|  |

 b. Leaf Thickness

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| --- |
|  |

 c. Stomata Density

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|   |

2. a. Do the class data agree with your results? List the similarities and differences.

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 b. Provide at least 3 reasons why differences may exist between your data and your classmates. Do NOT

 speculate- make statements that can be supported with observations; consider constants & measuring;

 consider your understanding about variation among individuals.

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| --- |
| Reason 1:  |
| Reason 2:  |
| Reason 3:  |

 c. Why is it better to draw conclusions based on class data as opposed to using just your own?

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3. Based on the class data, make a claim about each part of your experiment, using evidence from your work and reasoning to explain the claim.

|  |  |  |  |
| --- | --- | --- | --- |
|   | Claim | Evidence | Reasoning(Why) |
| *Example* | *Trees in the middle of a forest are taller.*  | *In our study plot, trees along the edge were 1.5m shorter than the trees in the interior.*  | *Trees in the middle of the forest grow taller in order to obtain sunlight for photosynthesis.*  |
| Leaf area |  |  |  |
| Leaf thickness |  |  |  |
| Stomata density |  |  |  |

4. Other than differences based on human error that are addressed in the previous question, can you come up with other factors as to why there might be differences in your data? Is there an indication that each species of tree has their own unique “growth strategy” to outcompete and survive?

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**Summary**

Write a short reflection on this lab addressing the following points:

* What would help you understand this lab better? What new things did you learn in this lab? How did this lab help you to remember or better understand the scientific process?

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