Lab 7: Transpiration

I. Framing the Investigation:

Background:

Trees absorb water primarily through their roots. They evaporate water through openings in their leaves in a process called transpiration. As with human respiration, trees tend to transpire more with increased temperatures, sunlight intensity, water supply, and size. When it gets too hot, though, transpiration will shut down as a result of closing stomata.

Many factors influence transpiration rates, including leaf shape, size, pores (stomata), and waxiness of the leaf surfaces. Where a particular tree species grows often depends upon how it has adapted its transpiration rate to a particular climate. Conifer needles are more efficient at retaining moisture than broadleaf trees because they have stiff, waxy leaves (needles) with small stomata that are recessed in the leaf surface. Because they are efficient in retaining water, conifers are found in drier and colder climates where water supplies are limited.

Plants transpire vast quantities of water - only one percent of all water a plant absorbs is used in photosynthesis; the rest is lost through transpiration. In one growing season, one corn plant transpires over 200 liters.

Transpiration, along with evaporation of moisture on land, provides almost two-thirds of the atmospheric moisture that falls as precipitation on land surfaces. The remaining one-third comes from the evaporation of the vast oceans.

Plant Adaptations:

Adaptations to dry environments include water storage in stems (no desert is completely without rain and cacti store the water when it rains. The leaves, a potential source of water loss, have been transformed into spines. The structure and toughness of the spines greatly cuts back on water loss compared to "normal" leaves and their great number provides some shade to the stem.

Cacti also have an important biochemical adaptation to desert life. Like all plants, cacti must undergo photosynthesis by using carbon dioxide and water, with sunlight as an energy source. Because photosynthesis requires light, it must be done during the day (don't confuse the dark reaction with this; the dark reaction doesn't require light, but it occurs during the day). Since carbon dioxide can only enter the plant through the stomata, opening the pores would result in a considerable amount of water loss during the day. In the desert, water loss can be life-threatening and during the hot daytime hours water loss would be at its worst. Cacti have a method for circumventing this problem. They open their stomata only at night, when air temperatures are much lower and water loss is at a minimum. The carbon dioxide taken in during the night is trapped by a special biochemical pathway and is stored in the form of organic acids. During the daytime cacti keep their stomata tightly closed, but they can still get the carbon dioxide they need from the organic acids produced during the night. The carbon dioxide is released from these organic acids during the day and photosynthesis is thus able to take place. This type of photosynthesis is called crassulacean acid metabolism (CAM). Although this method of photosynthesis is much slower than normal photosynthesis, the water savings more than offset the disadvantages, but cacti pay a price in that they are extremely slow growers.

Some desert plants avoid water loss through their leaves by dropping them during the driest parts of the year. These plants have tiny leaves to minimize water loss, but drop them when conditions get too dry. When it rains, they quickly produce new leaves and sometimes flowers. To further reduce water loss, desert plants have a thick cuticle, often with a waxy outer surface as well as a reduction in the number of stomata.

Purpose:

- To understand how water moves from roots to leaves in terms of the physical/chemical properties of water and the forces provided by differences in water potential.
- To understand the role of transpiration in the transport of water within a plant.
- To understand the structures used by plants to transport water and regulate water movement.
- To test the effects of environmental variables on rates of transpiration using a controlled experiment.
- To identify xylem and phloem cells, and relate the function of these vascular tissues to the structures of their cells.

Hypothesis:

Using variable assigned, develop a hypothesis, using the **If**, and, **then** concerning the affect environmental variables play on the process/rate of transpiration.

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II. Designing the Investigation:

Materials: Below make a list of materials used.

Procedure:

1. Wrap the entire root ball in a plastic bag, snug it up to the stem with string, mark with your group name, and weigh on Monday. Weigh each successive day for the entire week.

2. All groups put their **controls** in one place, those in front of the **fan** together, those in **bright light** together, and the last are **misted** and covered with another plastic bag are usually placed with the controls. **Dark** are placed in a drawer at the back of the room.

3. If your plant blooms, pinch the blooms off and be sure any leaves or blooms that fall off are put back in the center of the plant to be weighed each day so as not to represent water loss.

4. Write a hypothesis about what you think what will happen based on your knowledge of transpiration and plants.

5. Complete an experimental design diagram for this experiment.

III. Collecting and Presenting Data:

Results:

Determine the % change in mass over the week and graph. Be sure your graph has all of the appropriate titles and units.

$$\% \text{ change} = \frac{\text{Final Mass - Initial Mass}}{\text{Initial Mass}} \quad X\ 100$$

Variable ___________	**Initial mass (gm)**	**Final Mass (gm)**	**% Change**
Day 1			
Day 2			
Day 3			
Day 4			
Day 5			
Day 6			

Data Table 1: Individual Group Results

Average(s) of % Change

	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
Control						
Fan						
Dark						
Light						
Moisture						

Data Table 2: Class Average Results

IV. Analyzing and Interpreting Results:

Conclusion:

1. For this experiment, what was the independent variable and the dependent variable. What were the constants?

2. Explain why each of the conditions causes an increase or decrease in transpiration compared with the control.

3. How did each condition affect the gradient of water potential from the stem to leaf in the experimental plant?

4. What is the advantage to a plant of closed stomata when water is in short supply? What are the disadvantages?

5. Describe several adaptations that enable plants to reduce water loss from their leaves. Include both structural and physiological adaptations.

6. Why did you need to calculate the % water loss each day instead of graphing the total amount of water lost each day?

V. Reference: ????

VI. TEKS/TAKS:
TEKS1A, 1B, 2A, 2B, 2C, 2D, 3A, 4B, 5A, 12A, 12C, 13A
TAKS 1, 2, 3