

BIO 111 - Laboratory #12: Plant Anatomy and Plant Transpiration

- **Assigned pages:** Mader, S., et al. 2008. Inquiry of Life. pp. 103-111, 114-117, and C77-C79
 - ✓ Pages are listed for each section
 - ✓ **Time Saver Tip:** Set up the Transpiration experiment first; it takes a bit of time to set this up
 - ✓ **CHANGE of protocol:** Data is collected/ recorded **every 5 minutes for 30 minutes**
- **Field Trip NEXT WEEK:** You must wear closed shoes. Please, dress for the weather and wear clothes that you don't mind getting dirty or muddy; rain gear may be necessary.
- As we will be hiking through the woods next week, please, read ahead (pp. C81-C82) to prepare for next week's lab
- Check the biolab website (<http://web.cortland.edu/biolab/111.html>) for additional information and links to photos of the plants we'll see next week

I. Overview:

1. GOALS:

Objectives - at the end of laboratory #12 you should be able to:

- 1.) identify the five differences between monocots and eudicots and be able to recognize these key features (macroscopically and microscopically) in the plants and prepared slides you observe in lab
- 2.) identify a cross section and the specific tissues of herbaceous eudicot, herbaceous monocot, and woody eudicot and be able to state the functions of those tissues
- 3.) explain the "continuous water column" in plant xylem and know the theory of "cohesion-tension" and the function of stomata in this process
- 4.) define "transpiration pull" and describe the role that water plays in plant survival
- 5.) explain how certain conditions can affect the rate of transpiration

Key terms - you should be able to define:

Leaf Cross-section Terms:	Herbaceous Stem Terms:	Woody Eudicot Stem Terms:	Transpiration Experiment:
cuticle	epidermis	cork vs. cortex	transpiration
upper and lower epidermis	phloem (sieve tube member and companion cells) and xylem (vessel elements)	cork cambium vs. vascular cambium	stomatal transpiration vs. cuticular transpiration
leaf vein	cortex vs. pith	phloem	transpiration pull
palisade mesophyll	vascular cambium	primary xylem vs. secondary xylem	transpiration rate
spongy mesophyll	ground tissue (parenchyma)	spring wood vs. summer wood and annual rings	cohesion tension theory
stoma (pl. stomata)	bundle sheath cells	rays	
guard cells		pith	

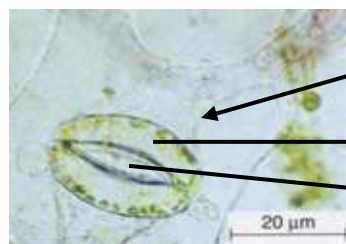
II. Plant Anatomy

1. Introduction:

- 1.) pp. 103-104: Read introduction and **answer** the questions for the shoot using the diagram (Fig. 9.1)
- 2.) p. 105, Fig. 9.2: **Study** the anatomical differences between monocots and eudicots

2. Organization of Leaves - Stomata:

- 1.) p. 106: Observe the demo slide of stomata in the lower epidermis (leaf used was removed from a *Tradescantia* plant ("Wandering Jew Plant"))
- 2.) Note the condition of the two guard cells that control the opening and closing of each stoma
- 3.) p. 106: Answer the questions for stomata



OPEN pair of guard cells
 guard cell
 stoma

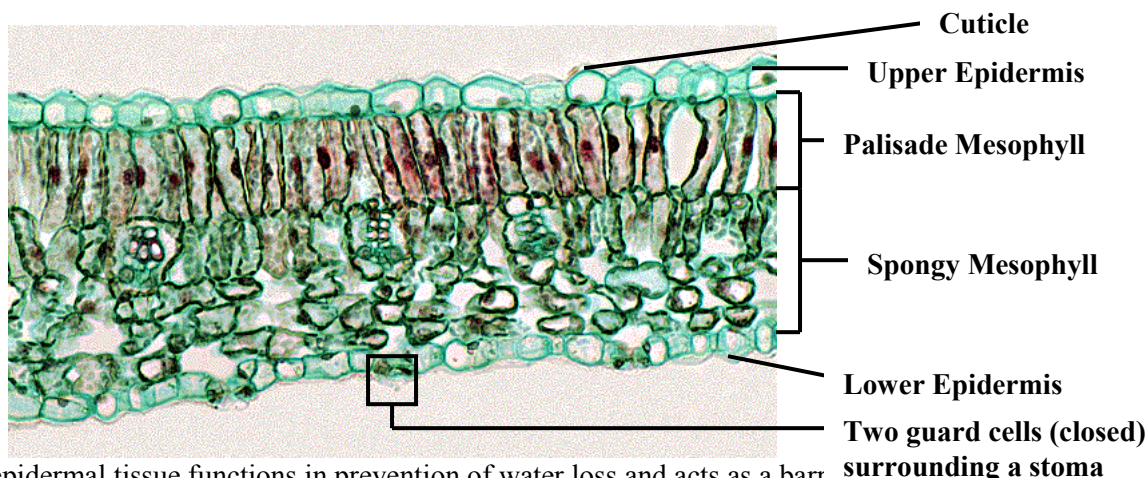


CLOSED pair of guard cells (note the "collapsed" appearance of the guard cells due to loss of turgor pressure)

3. Leaf Anatomy - Leaf Cross-section:

- 1.) **pp. C77-C78:** Read the introduction and descriptions of leaf tissues
- 2.) **p. 107:** Observe the prepared slide of the lilac (*Syringa* sp.) leaf cross-section; identify the tissues listed in the key terms under "Leaf Cross-section Terms" above
NOTE: Fig. 9.4 is a highly stylized drawing and the colors are not true to nature but the basic arrangement of the tissues is correct
- 3.) **p. 107:** Answer the questions 1 and 2 (a-f) for the leaf tissues

Leaf Structure - Cross section of a Lilac leaf (*Syringa* sp.) :



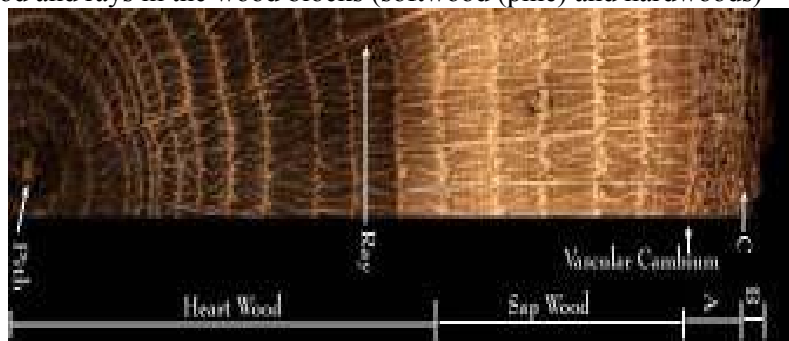
The epidermal tissue functions in prevention of water loss and acts as a barrier. Epidermal cells are closely packed, with little intercellular space. To further cut down on water loss, many plants have a waxy cuticle layer deposited on top of the epidermal cells. To facilitate gas exchange between the inner parts of leaves, stems, and fruits, plants have a series of openings known as stomata (singular stoma). Obviously these openings would allow gas exchange, but at a cost of water loss. Guard cells are bean-shaped cells covering the stomata opening. They regulate exchange of water vapor, oxygen and carbon dioxide through the stoma. Parenchyma cells are alive at maturity; they function in storage, photosynthesis, and as the bulk of ground and vascular tissues. Palisade parenchyma cells are elongated cells located just below the upper epidermis. Spongy mesophyll cells occur below the palisade cells.

4. Organization of Stems - Stem Cross-sections:

- 1.) **p.108, "Herbaceous Eudicot Stem"** : Using the labeled photos of Fig 9.5, **identify** the tissues in the prepared slide of a cross-section from a sunflower (*Helianthus* sp.) stem
- 2.) **p. 109, "Monocot Stem"**: Using the labeled photos of Fig. 9.6, **identify** the tissues in the prepared slide of a cross-section of a stem of corn (*Zea mays*).

5. Organization of Stems - Woody Eudicot Stem - Stem Cross-section and Wood Blocks:

- 1.) **pp. 110-111 (top):** Read the descriptions of terms and using the labeled photos of the stem cross-sections (Fig. 9.7), **identify** the tissues in a prepared slide of a cross-section of a 3 yr old stem of a basswood tree (*Tilia americana*). **NOTE:** the larger diameter xylem vessels are formed in spring ("springwood"); summerwood xylem vessels have a narrower diameter. Can you think of a reason for this difference?
- 2.) **Identify** the spring wood, summer wood and rays in the wood blocks (softwood (pine) and hardwoods)



III. Plant Transpiration - Experiment:

1. Introduction:

- 1.) **pp. C77-C79:** Read the descriptions for transpiration through different tissues and transpiration rate
- 2.) **p. C79:** Answer questions 1, 2, 6, and 7
- 3.) **pp. 114-115, Demonstration:** View the demo preps of a celery stem ("stalk") and a carnation stem that have been sitting in colored water. How has the colored water entered these plants?

Transpiration - Background Information:

- **Transpiration** is the loss of water vapor from the leaves and stems of plants.
- Xylem tubes are made of dead cells that have sieve-like ends to allow water flow. The "**cohesion tension**" **theory** states that water moves through xylem because it is pulled. Water is a polar molecule so it bonds to other water molecules. Therefore, when water molecules in the leaves are pulled into the air by evaporation, all the water that is in the xylem tubes moves up the stems towards the leaves. This movement of water through the stem is called the **transpiration pull**. Cohesion is the attraction of water to the sides of the xylem tubes, which are very thin. This helps the water travel a little. Evaporation "powers" the transpirational pull.
- Guard cells can open and close stomata to regulate transpiration.
- If stomata open, transpiration increases, and if guard cells are closed transpiration decreases. **Light** effects blue-light receptors in the leaves that open stomata by creating a potassium gradient and causing the guard cells to absorb water. **Hot temperatures** cause stomates to close. **Wind** causes the water vapor that is emitted from the stomates to travel very quickly, causing the air near the leaves to be dryer than it would be without wind. This causes a greater difference between water concentration between the stomatal air and the outside air, causing more transpiration. **Humidity** does the opposite. Because there is less difference between inner and outer air, the water does not travel out of the leaf as much, causing transpiration to decrease.

2. Experimental Protocol:

- **TWO experiments are run one after the other; use the same set-up for both experiments**
 - **Work in groups of FOUR**
 - **Data are collected/recorded EVERY 5 minutes for 30 minutes**
- 1.) **pp. 115-116:** Read and follow the protocol for assembling the transpirometer
 - 2.) **Transpiration under STANDARD Conditions:**
 - (1.) **p. 116:** Read and follow the protocol for testing transpiration under standard conditions
 - (2.) **p. 117:** Record you data every 5 minutes in Table 9.3 under "**Standard Conditions**"; enter your data as points on the graph
 - 3.) **Transpiration under EXPERIMENTAL Conditions:**
 - (1.) **p. 116:** Choose one experimental condition, increased heat (1a.), increased humidity (1b.), OR increased air flow/wind (1c.). Write your hypothesis on the line provided below the number of the condition you choose. Check with your instructor, if you want to design an experimental condition not on the list.
 - (2.) **p. 116:** Follow the experimental protocol for the experimental condition you chose.
 - (3.) **p. 117:** Record you data every 5 minutes in Table 9.3 under "**Test Conditions**"; enter your data as points on the graph (use a different symbol/color than you used for the standard conditions and a legend indicating which symbol represents each condition)
 - 4.) **Conclusions:**
 - (1.) **p. 117:** AFTER you have graphed your data, answer the questions (bottom half of page) for the condition that YOU TESTED.
 - (2.) **p. 117:** Check with OTHER groups to see what they got for the other two experimental conditions
NOTE: MAKE SURE you know what the results were for the different experimental conditions; you will be asked to interpret a graph with these data on the **practical exam**.

IV. Review:

1. **p. 118:** Answer questions 1-9, 13-16, and 18.